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Engineer

THE PROFESSIONAL BULLETIN FOR ARMY ENGINEERS

Operation Continue Hope

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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

Since my last chat, I have had the opportunity to speak with brigade and battalion commanders throughout the engineer force and with many of our great junior officers and noncommissioned officers. It is clear that we are hitting the mark as active, enthusiastic members of the combined arms team. We consistently bring to the warfight outstanding support to the total force and play an integral role in ensuring the attainment of our ultimate goal—decisive victory!

So that we may continue to bring outstanding support to the warfight, engineer leaders must prepare to operate in a tactical environment that's inundated with real time, detailed battlefield information. Technological innovations during the early part of the 21st century will mark the beginning of a battle command era where information drives performance and enhances tempo, lethality, and survivability. Engineers will have fully digitized, joint battlefield communications and information systems that unite strategic and tactical information nodes, including individual combat vehicles, sensors, and even intelligent minefields.

Digitization of the battlefield is a major leap-ahead in the conduct of war and directly supports the combat leader's integration of maneuver, firepower, and protection capabilities. As we enter this age of "third wave technology warfare," we must be prepared for the profound effects it will have. It will affect not only the way we conduct war, but also how we terminate hostilities, execute peace operations, and "clean-up" dirty battlefields.

As the world changes, our Army is being asked to take on more nontraditional missions like peace keeping, humanitarian aid and even battlefield cleanup. Captain Kauffman's article (page 2) describes how engineers are key players now in these nontraditional missions in Somalia. As the Army's proponent for mine warfare, the challenges in this arena are just as great as they would be in hostile warfare. The worldwide proliferation of unexploded land mines constitutes a very real threat to noncombatants and peacekeeping forces alike. Current studies indicate that more than 85 million land mines lie unexploded in at least 62 nations (see Major Kowadlo's article, page 18). The international community is becoming aroused about the humanitarian concerns and potential casualties from these unexploded mines. While this deplorable situation may defy simple solutions, we have taken the first step toward ensuring that future US mines do not contribute to this problem.

As has been accomplished with the M16 antipersonnel mine, other conventional mines in their current configurations will be retired from use by US military forces. Existing mine inventories will be retrofitted with advanced fusing mechanisms that integrate conventional mines into the intelligent mine arena with digitized command and control capabilities. We envision the need for both antitank and antipersonnel munitions on future battlefields, but not without assurance that positive command and control are maintained to eliminate potential residual lethality.

Although warfare in the early 21st century will be totally joint operations, the Army will remain as the centerpiece for land force dominance. US forces will continue to rely on mine warfare to rapidly terminate conflicts. Our Army's mine-warfare program ensures that future battlefields will favor friendly forces while significantly reducing the potential for collateral damage after the battle is done.

Third wave technology provides the road map for the evolution of mine warfare. We are developing future smart mines that interface with multipurpose sensor networks; locate, identify, and accurately engage enemy combat; and then either command detonate or autonomously self-neutralize for potential use another day. These capabilities will become major considerations as the Army gets involved with operations other than war and must deal with situations where long-term mining requirements exist. This technology allows us to take constructive measures to avoid accidental encounters with noncombatants and not lose the detrimental effects of landmines.

This is just one example that shows how third wave technology will impact on the way engineer leaders support combined arms operations in the 21st century. I challenge each of you to stay abreast of this evolution and remain intellectually agile as we find new ways of applying technology. Engineers must ensure that applications of third wave technology will produce DECISIVE VICTORY!

Essayons!

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***Cover photo:** A U.S. Army engineer from the 10th Mountain Division guards an alley near the engineer base in Mogadishu, Somalia, during Operation Continue Hope.*

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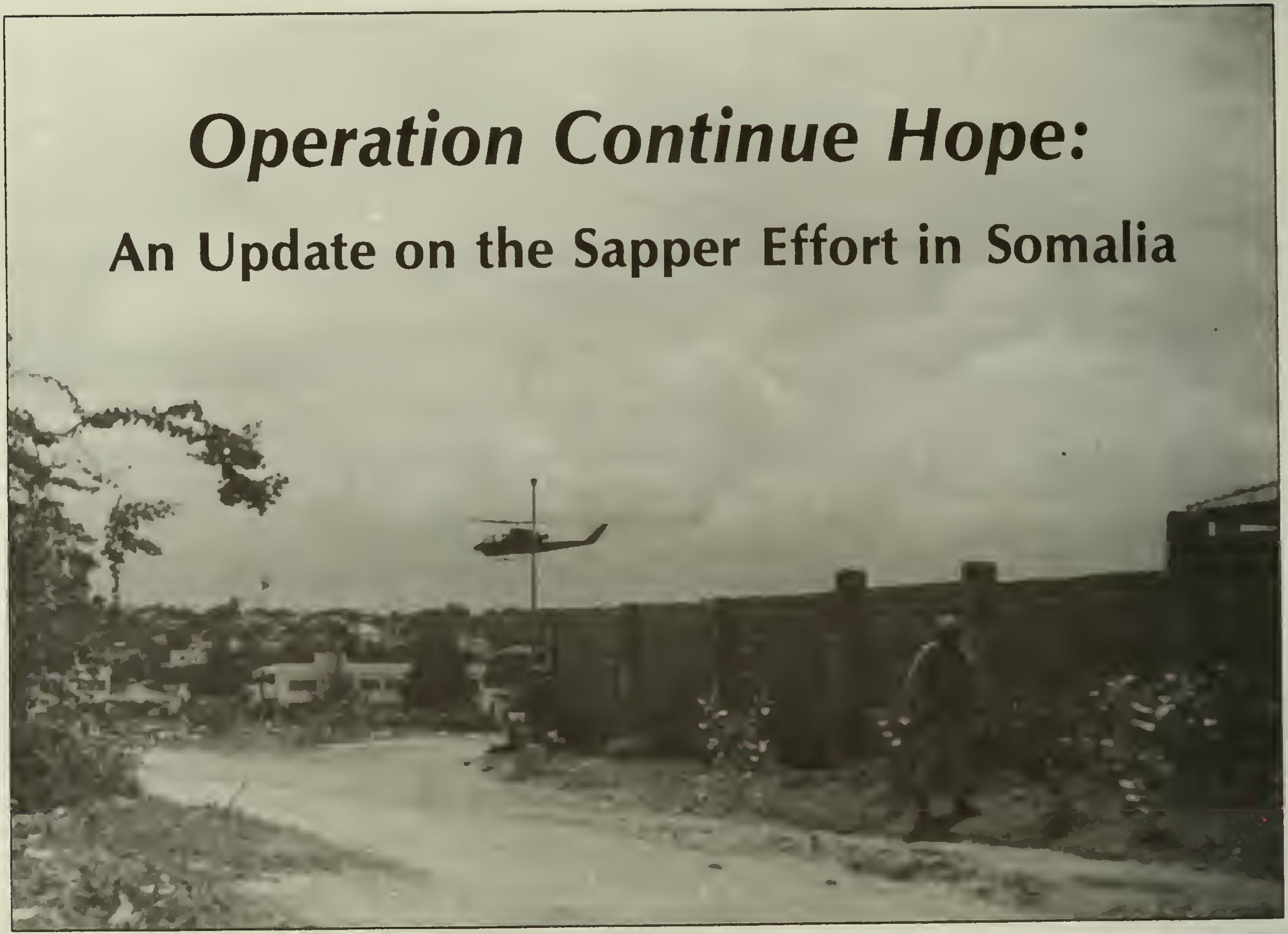
Operation Continue Hope:

An Update on the Sapper Effort in Somalia



By Captain Sheldon S. Kauffman

Editor's Note: *Combat engineer missions on the second and third rotations to Somalia differed significantly from those accomplished by engineer units during the early months of Operation Restore Hope. The following narrative describes how tensions increased and operations shifted from peacemaking in the first rotation to peacekeeping and small combat operations in later rotations.*

Important changes have taken place in Somalia since US ground troops first deployed to that country in December 1992 to support Operation Restore Hope. Most of the country is now stabilized, the roads are relatively safe, and some of the infighting among Somali clans has been replaced by more peaceful means of decision making. Mogadishu, the capital, remains a hot bed of civil and military strife, however. United Nations and US peacekeepers are currently conducting combat operations in and around Mogadishu, including force protection and sustainment. The peacekeepers continue to destroy captured munitions caches and provide road security.

This article describes sapper activities in Somalia since April 1993. From first to last, engineer equipment operators and combat engineers (sappers) have been critical to the success of

Operation Continue Hope, as it is now called.

Second Rotation

Sappers of Charlie Company, 41st Engineer Battalion, 10th Mountain Division (Light Infantry) deployed to Somalia with 1st Brigade Headquarters and 1-22 Infantry to replace the battalion's Bravo Company. The Bravo Company sappers were the first to deploy in-country with Task Force 2-87 in December 1992 and the last to leave from the initial rotation of Operation Restore Hope. Mission turnover was completed on 5 April. Two days later, Charlie Company's 2nd Platoon, led by 2LT Scott Daniels, convoyed south to the village of Marka. *There it performed extensive engineer route, bridge and dam reconnaissance, and provided mobility and demolition support to Task Force 1-22's recon and security patrols in and around Marka.*

During those first patrols, the young sappers learned some hard lessons about the low-intensity conflict (LIC) environment. For most members of the task force, having numerous civilians around them while they worked was a new experience. Several soldiers learned the hard way to secure valuable and sensitive items and to maintain tight operational security. It was almost impossible to decide which local people could be trusted and which could not. Unlike the large, fenced-in compounds that protected soldiers against hostile combatants and unwanted civilian attention in larger cities, the temporary unit perimeters in Marka provided little or no protection against the hordes of nosy, begging noncombatants.

In addition to recon, minesweeps and munitions denial, the sappers and engineer equipment operators rebuilt a dam and drainage ditch on Marka's north side. This construction was done to relieve flooding, reopen the road and reduce the mosquito population. During the construction, the engineers learned more valuable lessons about beach excavation; i.e. that tracked vehicles do not fare well in wet sand and that construction on beaches is complicated by the extremely high water table.

While 2nd Platoon was involved in the combat operations, contacts with the local population and nation building typical of LIC, 1LT Dan Koprowski, the assistant brigade engineer (ABE), was learning another hard lesson about LIC. He was tasked to do an aerial recon of nearly all the major routes in southern Somalia in preparation for repatriation operations. LT Koprowski was dismayed to discover that many roads built or reopened only two months earlier were now impassable due to intervening rains and massive shortfalls in maintenance.

US and UN forces found no existing infrastructure in Somalia when they arrived in 1992. Even when they provided an infrastructure, the country lacked a civil support system capable of using or maintaining it. The routes surveyed by LT Koprowski had to be reopened before large-scale repatriation or food distribution could continue. The lesson is clear:

Sappers prepare ordnance for disposal. Ordnance disposal was a major mission for engineers throughout Operations Restore and Continue Hope.

Sappers prepare an expedient breaching charge during urban warfare training in Mogadishu. On several occasions, breaching charges enabled patrols to withdraw safely from sniper fire during operations in the city.

Given limited host-nation support and a nonlinear battlefield, continuous battlefield analysis and knowledge of the current situation are just as important as they are in more conventional operations.

While LT Koprowski updated the engineer battlefield assessment, the ABE noncommissioned officer (NCO), SGT Shannon Brown, flew to Baledogle to help with force protection at the local airfield. To avoid pulling sapper labor from combat operations, SGT Brown provided the needed engineer expertise to infantrymen and aviators. *He helped them design protective obstacles and survivability positions, instructed their junior leaders on construction* and began the massive task of accounting for AM2 airfield matting throughout Baledogle, Mogadishu and southern Somalia. These operations continued until May, with American forces fine-tuning their standing operating procedures.

When United Nations Operations Somalia (UNOSOM) took control of the relief effort, 1st Brigade and its subordinate units became the Quick Reaction Force (QRF). As conditions in Marka normalized, the QRF transferred control to the Pakistanis and the task force and sapper platoon returned to Mogadishu. There they conducted civil/military operations at the Lafoole orphanage. They repaired the school building, built benches and desks, put up protective barriers and provided security for children and care providers. The ABE section redesigned and oversaw new construction at the Mogadishu and Baledogle airfields and continued managing sustainment engineering for the QRF.

The QRF began to reinforce the Belgians in Kismayo later in May as tensions with the local population increased. LT Koprowski served as battle captain in the brigade tactical operations center. LT Daniels split his platoon into squads to support a cordon and search of the city. The Kismayo operation lasted two weeks and ended without incident.

Soon after returning to Mogadishu, the task force moved to a base camp in Bardera. From there they conducted a search and attack into Garbahari *in which the sappers put five anti-aircraft guns out of action with thermite grenades.* Each sapper easily carried several of these useful grenades. Although thermite grenades cannot destroy their targets, they can make them inoperable.

After the task force returned to Bardera, 1st squad flew back to Kismayo with the QRF's quick reaction company to prepare for scheduled peace talks.

The QRF was soon called back to Mogadishu to rescue an ambushed Pakistani convoy. This ambush, which left 23 Pakistani peacekeepers dead, marked the sudden collapse of an uneasy peace in Mogadishu. UNOSOM responded to the ambush with aggressive cordon and search operations and attacks on suspected Aideed strongholds.

On 12 June the sapper platoon executed a major demolition of captured mortar rounds, destroying more than 1,000 pounds of ordnance. They assembled the rounds under explosive ordnance disposal (EOD) supervision, placing the explosive charges and rounds in consecutive layers. EOD personnel then initiated the firing devices set up by the sappers. Thus began a sometimes confusing relationship between the sappers and EOD personnel. For the first major demolition, the sappers needed EOD supervision to teach them how to place charges properly. Later the sappers became confident of their ability to neutralize conventional ordnance. Current doctrine does not adequately address the lash-up of engineers and EOD in large-scale operations, leaving the issue to be resolved by local ground force commanders.

Escalating Tensions

As June progressed, a pattern of escalating tensions between hostile elements in Somalia and UN and US forces became increasingly evident. LT Koprowski and SGT Brown served as liaison to Italian special forces to call in American attack helicopter fires during a cordon and search of Aideed's home on 17 June. Two days later, 2nd Platoon raided an artillery firing position and destroyed 34 artillery pieces. Later they participated in a raid on a weapons storage site and destroyed thousands of pounds of artillery and small arms ammunition.

Although enemy contacts during combat became frequent by the end of June, US casualties remained low. The US engineers wounded during Operation Restore Hope's second rotation were construction engineers, not sappers involved in combat operations. Three heavy equipment operators from a corps support group were wounded in two incidents while moving between work sites. On both occasions their equipment came under fire after hitting mines, and allied units escorting the convoy left the engineers when the firing began. These incidents highlight the importance of running all convoys as combat operations and the need for detailed planning and practice, especially when units work with allied forces.

Enemy attacks of varying intensity on friendly compounds in and around Mogadishu occurred almost nightly by late June. These attacks involved relatively light small arms fire, but the threat to the compounds increased significantly on 3 July, when accurate mortar fire hit the airfield. A rocket-propelled grenade (RPG) attack on the Hunter Base logistics site resulted in two casualties on 6 July.

LT Daniels and three other sappers participated in a raid on 12 July against Abdi House, the home of one of Aideed's top advisors and a known meeting place of his supporters. The raid began with extensive preparation of the objective with TOW missiles fired from Cobra gunships. In the assault phase, ground troops entered the house. Sappers moved through the house identifying targets to destroy and collecting captured weapons. As the infantry withdrew from the house, the sappers initiated thermite grenades on the targets. They left on the last helicopter to depart the objective, taking one prisoner. Total time on target: 9 minutes, 30 seconds.

Cordon and search missions continued throughout July as the force protection effort around the compounds intensified. *Sappers and other forces destroyed unoccupied buildings around the US Embassy and University compounds to clear fields of fire and deny those facilities to Somali snipers.* LT Koprowski developed an obstacle plan to protect the airfield. The equipment section used dozers and small emplacement excavators to reinforce clearing operations and increase survivability efforts on all compounds while the sustainment effort continued.

Third Rotation

The main body of 2-14 Infantry and 1/C/41 Engineers, led by 2LT Bruce Nelson, arrived in Mogadishu 5 August to relieve Task Force 1-22. Hostile fire increased significantly when Somali gunmen realized US forces were changing over. As 2/C/41 soldiers sat in the airfield passenger holding area awaiting transportation home, they were pounded by mortar and rocket fire. Meanwhile, Task Force 2-14 began aggressive cordon and searches with the 1/C/41 sappers, *who also helped the infantry and military police (MP) man checkpoints around the city.* Using mine detectors to search detainees, the sappers discovered many weapons hidden under the Somalis' thick layers of clothing.

Countermobility efforts increased dramatically in response to enemy attacks. 1/C sappers directed emplacement of miles of wire obstacles and antitank ditches around the airfield. CPT Matt Snyder and SSG Randy Montano, who replaced LT Koprowski and SGT Brown as ABE and ABE NCO, requested that a mechanized engineer platoon with combat engineer vehicles and mine rollers be brought into Somalia to assist the QRF in keeping main supply routes (MSRs) open. To reduce the threat caused by travel through Mogadishu, the QRF opened a bypass route around the city's southern edge. While CPT Snyder coordinated for additional equipment and personnel, SSG Montano's management of the new equipment section increased their output. The engineers added 70,000 square feet to the already huge AM2 airfield helipad (over 1,000 by 400 feet) designed during the second rotation by LT Koprowski.

On 15 August, the 1/C participated in another raid aimed at

Engineers in Task Force 1-22 conduct convoy security in Mogadishu. In Somalia, every convoy had to be treated like a combat operation.

arresting key Aideed advisors believed responsible for the July killings of US Special Forces and MP soldiers. The sappers created an expedient breach charge by filling a U-shaped picket with 8 pounds of C-4 explosive. They blew open a new entrance to the building by wedging the preconfigured charge against an outer wall and detonating it. This enabled the assault team to surprise and overwhelm the enemy within.

Sappers continued to improve protective barriers and survivability positions on the compounds. The ABE coordinated with UNOSOM's operational, intelligence and engineer officers to analyze Somali actions and develop effective countermeasures. On 19 August UNOSOM sustained two minor casualties from the first of several command-detonated mines along the MSRs. To counter these mines, UNOSOM fabricated a forklift-mounted mine roller from tracked-vehicle road wheels and angle iron. The makeshift roller was only minimally effective and reinforced the need for mechanized engineers and track-mounted mine rollers.

Enemy activity subsided temporarily in late August, perhaps due to aggressive activity by fresh US and UN troops. However, the airfield and embassy compounds were soon hit hard again by Somali rocket and mortar fire. After enjoying a week doing vertical construction tasks in the task force area, the sappers again went on the offensive. They conducted a deliberate attack with the task force on a suspected cache site.

Combat Operations

On 25 September, PV2 Thomas Asbury became the first US sapper to sustain a combat-related injury when his convoy came under direct fire. In a hurry to dismount the truck and return fire with his M60 machine gun, he fell off the truck, breaking one rib and bruising several others. This happened when 1st Platoon participated in a rescue team to retrieve a helicopter shot down by Somali gunmen. Four other Americans were wounded on this mission and one was killed in action. Despite the escalating threat, sapper morale remained high. The platoon medic, PFC Mark Jackson, was always one of the first to reach the scene in every major action.

October began with the sappers again doing mine sweeps along the MSRs. Tragedy struck when a helicopter carrying US Army Rangers back from a secret raid was shot down on 3 October, in downtown Mogadishu. The Rangers were trapped inside the helicopter. Efforts by the rest of the Rangers to rescue them were unsuccessful.

Finally, UNOSOM organized a major rescue effort that included Malaysian mechanized forces and the QRF. LT Nelson, the 1/C/41 platoon leader, accompanied SSG Reginald Maxwell's squad with the lead force; one squad went with the follow-on force; another remained at the airfield to react to hot spots in the city. The lead sappers moved to the objective in Malaysian M113 armored personnel carriers (APC), with LT Nelson riding in one APC and SSG Maxwell in another. After clearing three roadblocks en route, the APCs separated at the fourth roadblock. LT Nelson and his team were forced to continue on foot.

Meanwhile, SSG Maxwell's APC was disabled by an RPG round that killed the Malaysian driver. As the ramp dropped for the sappers to dismount, they were hit by a second RPG volley that wounded SGT Cornell Houston and PV2 Xiong Ly. Both soldiers were able to continue the mission. As SSG Maxwell checked his team's status, a third RPG volley wounded him in the knee. Again, the sappers continued the mission, collecting the remaining wounded from the rescue force.

They began withdrawing toward the compound, leading the way despite persistent heavy incoming fire. SGT Houston and PV Ly, who were serving as point men for the wounded, reached the end of the wall they were using for cover. Fire beyond the wall grew, then slackened like a flowing and ebbing tide. Finally, SGT Houston decided it was time to move. He and PV Ly cleared the corner of the wall and began crossing the open area. Almost at once, they were cut down by bursts of heavy RPG, machine gun and small arms fire. The withdrawal continued along a different route until the sappers and the wounded they were escorting were picked up by trucks from the follow-on force.

LT Nelson's team continued on toward the objective despite intense fire. A 7.62-millimeter round smashed the magazine in SPC Eric Fullgraf's M16 rifle and gave him a superficial shrapnel wound in the abdomen. A second later, another round tore through his upper right arm and shoulder, luckily missing the bone. An infantry soldier standing between LT Nelson and SPC Fullgraf was not so lucky: he was killed by enemy fire. LT Nelson had to quit short of the objective due to casualties and enemy fire, which was so heavy that the team took more than 7 hours to withdraw slightly more than 2 miles.

In some ways the sappers were lucky. One mortar round impacted within 5 feet of them but incredibly no one was seriously hurt. Another mortar round struck the tree beneath which LT Nelson was crouching. The tree absorbed most of the blast and shrapnel and no one was hurt. And while the team was moving along a fence approaching a gate, an incoming RPG round barely missed SGT McCue, hit the gate and blew it open. Another time it was skill, not luck, that saved the lives of sappers and the wounded they were escorting. Shortly before reaching the pick-up point, LT Nelson and his team were pinned down against the near side of a wall they were using for cover. The sappers used some of their portable demolitions to blow a hole in the wall so the force could pass through it safely.

This rescue mission cost UNOSOM more than 75 casualties. When the rescue forces reassembled at the University and Embassy compounds, SSG Maxwell, SGT Houston and PV Ly were evacuated to Germany for medical treatment. SGT Houston died in Germany of the wounds he received in combat. SSG Maxwell and PV Ly later returned to the US on convalescent leave and have since rejoined their company at Fort Drum. SPC Fullgraf was treated at the aid station and returned to light duty with his platoon.

Force Buildup

As a result of the costly mission to rescue the Rangers, the US government authorized a new build-up of American troop strength in Somalia. For Fort Drum, this meant sending 2-22 Infantry, A-41 Engineers and more support units. *Since this latest build-up, US engineers in Somalia have focused on preparing base camps for the expanded force, increasing survivability efforts and improving MSR security.* The build-up allowed the QRF to again become a true quick-reaction force. 1/C sappers trained on breaching drills, and trained marksmanship, physical fitness and basic soldier skills. Well aware of the unstable situation in Mogadishu, they fully briefed new sappers to prepare them for possible conflict escalation.

Sappers in all three rotations built weapons ranges for themselves and others to use in perfecting marksmanship. They also completed vertical construction projects for various customers. Equipment operators worked almost nonstop during their rotations to improve survivability and support the constant sustainment needs of the compounds. Sappers conducted many more cordon and search and demolitions operations. Periodically, they took time out to enjoy the sunshine and relax from the tensions of combat and being so far from home.

The sappers, medics, and equipment operators of Charlie Company, 41st Engineers, are combat-proven soldiers. As the last sappers return to Fort Drum, C-41 is using the lessons learned to prepare for an upcoming rotation at the Joint Readiness Training Center and for the next real-world mission.

Captain Sheldon S. Kauffman is currently serving as commander of C Company, 41st Engineer Battalion, 10th Mountain Division (Light Infantry), Fort Drum, NY. Previous assignments include service in Germany and in Southwest Asia during Operations Desert Shield/Desert Storm as platoon leader, assistant S3 and S4, company XO and Adjutant of 41st Engineer Battalion. A graduate of EOAC and the U.S. Army Ranger School, Captain Kauffman holds a B.S. in nuclear engineering from Rensselaer Polytechnic Institute, Troy, NY.

After a Year in Somalia:

A Battalion Commander's View

By Lieutenant Colonel Peter T. Madsen

A year ago the US Army got the call to support the humanitarian relief effort in Somalia. Since then many great soldiers have faithfully served the United Nations efforts, first by assisting the effort to relieve widespread starvation and then by maintaining peaceful conditions to encourage nation building. Peacemaking and peacekeeping. Not new missions but ones that US forces are likely to encounter more often in the post-Cold War environment. Engineers will play a major role in both missions.

During peacemaking operations in Somalia, engineers in all services improved the country's infrastructure dramatically, thereby improving food distribution and security. In the peacekeeping phase of Operation Restore Hope, engineers gave key support to urban security operations while also maintaining roads and major city thoroughfares. Force protection and base construction support were major engineer missions throughout both phases.

After this year's experience, I believe it is worthwhile to assess, evaluate and comment. There are lessons in the Somalia experience that will translate to future contingency operations. The lessons cross the spectrum of training, doctrine, facilities, equipment and personnel; they are worthy of discussion.

Good News

The good news is that the soldiers in the force are highly motivated, brave young men and women willing to do any mission they are tasked to perform. Young engineer soldiers in Somalia followed leaders into combat operations less than two months after graduation from One Station Unit Training at Fort Leonard Wood. And they did well.

In a land where everything is scarce, leaders found ways to execute seemingly impossible tasks. Civil affairs, psychological operations and interservice coordination were performed exceedingly well by engineers with little prior experience. Units continue to demonstrate their ability to deploy, respond to a crisis, and plan and execute missions. Soldiers continue to demonstrate great flexibility and versatility. In addition to normal METL-related missions, sappers built Bailey bridges and performed base camp master planning while combat heavy engineers constructed water well rigs, built playgrounds at orphanages, and roofed base camp villages with sheet metal. These are just a few examples of the varied missions engineers performed.

What does seem to challenge our soldiers are long periods of deployment. Short, fast-paced field training exercises do not prepare our soldiers well for the monotony of a long deployment. Yet our leaders stood up to that challenge as well, most often by providing tough training and organizing athletics.

But what are the lessons?

Urban Terrain

Somalia has given the Army a significant urban terrain experience. Engineer support to maneuver forces on patrols, convoys, and guard duty takes on new meaning when it is conducted in a populated city. Cordon and search is the new urban maneuver for patrolling. Key reaction drills to sniper fire or an attack are very different in a city alley as opposed those occurring on a training area range road. Sappers have become key players on urban patrols. Packing demolitions in their rucksacks, they are always ready to blow holes in walls that might otherwise corner them.

Military operations in urban terrain (MOUT) training has always been part of our calendar, but where can Army trainers replicate a city of one million, complete with women, children, refugees and street markets? Future contingency missions, whether for peacekeeping or peacemaking purposes, are likely to put soldiers in hostile villages, towns and cities. United Nations forces are struggling now in the cities of Bosnia. In Haiti, Port-au-Prince will always be the center of activity.

Training for Army engineers in the United States is conducted primarily in nonurban environments. Training conducted at the National Training Center, Joint Readiness Training Center, Ranger School, Sapper Leader Course, and at most home station field training exercises are examples. MOUT cities are expensive and require an installation MCA (military construction, Army) investment. While that investment is needed, units must look for other ways to train now. Old World War II barracks on a remote corner of many installations can serve as urban training grounds until better facilities are built. Urban training must be a priority.

Countermine Operations

Every conflict since World War II has identified the need to improve the way we conduct countermine operations. Soldiers in Somalia today are facing mine threats that range from old, patterned minefields buried in remote locations years ago to command-detonated nuisance mines on key city thoroughfares. Vast quantities of mines are often found during cordon and search missions or in remote cache points. Mines from all mine-producing nations are found in Somalia.

Yet our mine-detection technology still risks soldiers' lives. Soldiers walking with hand-held detectors or riding in a D7 dozer with a plow attachment and cab enclosure still search for them. Forward looking infrared (FLIR) devices in helicopters have some success in identifying mines, but putting a helicopter at risk above a city is not the answer. Robotic detectors make more sense.

Protective measures are another issue. Army Rangers went to Somalia in September 1993 with new suits of body armor. Since then, more suits have been procured for the forces in theater. Where was this body armor in January, when units first deployed? Where are the mine-blast kits for HWMMVs as they escort food convoys in to and out of cities?

From this battalion commander's perspective, a variety of activities are working pieces of the mine issue at Fort Belvoir, Fort Leonard Wood, and in Charlottesville, Virginia. But who has the lead and who is directing the scarce research and development resources to eliminate overlaps and voids? Mine recognition guides from each organization show the independence of their efforts.

The facts are scary. As urban populations turn hostile to peacekeepers, incidences of command-detonated mines and booby trap usage rise. Our best detection measure is still the individual soldier with a hand-held device. We need to do much better.

Force Protection

The most important mission for a deployed unit is force protection. Heavy and light task forces were flown to Somalia in October 1993 to improve force protection. On their heels a combat heavy engineer battalion was shipped in with enough Class IV materials to build the base for the heavy force.

Engineers will always play a key role in designing and constructing the security measures needed to protect deployed units and improve their living conditions. Wire fences, guard towers, checkpoints and roadblocks are examples of rudimentary construction that combat engineers deployed with maneuver forces will always be asked to provide. They will need the power tools and skills that we took away from combat engineer organizations many years ago. The same requirements for combat engineers were identified during Desert Shield. Units fare well today because many good carpenters still exist within the NCO Corps, but time is running out. The future will have fewer combat heavy engineer battalions. It is time to retool and retrain our engineers.

The Challenge

Undoubtedly, other engineer lessons can be drawn from our experiences in Somalia. Yet recent experiences of combat in an urban environment, countermine operations, and force-protection challenges highlight engineer training, equipment and doctrinal needs. These same challenges will likely be faced in future peacemaking and peacekeeping operations. The challenges engineers faced in Somalia have taught us lessons we must not ignore.

Lieutenant Colonel Peter T. Madsen is the battalion commander for the 41st Engineer Battalion, 10th Mountain Division. Other assignments included tours with the 82nd Airborne Division, Germany, and the Missouri River Division. A CGSC graduate, he holds a bachelors degree from West Point and a masters degree in civil engineering from Georgia Tech.

Reserve Engineer Training in Europe:
The 412th ENCOM Program

By Lieutenant Colonel Dale W. Jones

Until recently, meaningful mission-oriented training opportunities in Europe for Reserve Component (RC) combat heavy engineers were few and far between. Past REFORGER (Return of Forces to Germany) exercises, for example, offered excellent training for combat engineers at corps and division levels. Little attention, however, was paid to engineers operating at echelons above corps (EAC), where most combat heavy battalions are located. Now, the 412th Engineer Command (ENCOM), in conjunction with the engineer staff of the United States Army, Europe (USAREUR), has developed a remedy. It's a program that simultaneously supports USAREUR's sustainment engineering requirements while affording valuable METL training to the combat heavy battalions and other EAC engineer units of the National Guard and Army Reserve.

Background

Two factors are principally responsible for the increased training opportunities for RC combat heavy engineer units in Europe and the development of the 412th ENCOM program: the Engineer Restructure Initiative (ERI) and the ongoing drawdown of forces in theater.

Emphasizing mobility and offensive action in support of maneuver elements, ERI reorganized divisional engineer support from one large engineer battalion to an engineer brigade that includes an austere brigade headquarters and three small but equipment-intensive battalions. More importantly for the combat heavy

Members of the 216th Engineers (Ohio National Guard) use a SEE to upgrade ranges at the Grafenwoehr Training Area.

Members of the 216th Engineer Battalion demolish a World War II-vintage bunker. Some demolition projects were required to remove safety hazards prior to construction.

battalions, however, ERI removed them from the corps engineer brigade structure. They are now EAC assets with responsibility in the corps area.

In USAREUR, ERI was initiated about the same time that the Army's drawdown began in theater. The 18th Engineer Brigade, a theater asset consisting of four combat heavy engineer battalions, was inactivated in 1992. Only one of its heavy battalions, the 94th (-), remains in theater. Two battalions and the brigade headquarters were inactivated, while the 293rd Engineer Battalion was restructured under ERI and reflagged as the 40th Engineer Battalion of the 1st Armored Division.

The upshot of this is that although sustainment engineering requirements in theater diminished somewhat as a result of the drawdown, sustainment engineering capability (the combat heavy engineer battalions) was drastically reduced (Figure 1). Only one heavy battalion (-) and one construction support equipment company capable of performing troop construction and sustainment engineering missions now reside in theater. This has resulted in a significant shortfall between sustainment requirements and capabilities.

Program Development

The 412th ENCOM program addresses a significant portion of the shortfall between engineer requirements and capabilities. Within a month of receiving the tasking, the ENCOM Forward, a USAREUR-based, full-time planning and operations staff, had developed a concept for RC training and construction in Europe. The 22 AGR and Reserve soldiers making up the ENCOM Forward then developed a marketing strategy that was agreeable to both USAREUR and RC principal staff. By the time the 412th ENCOM staff exercise (STAFFEX 93) was conducted in February 1993, they had developed a draft concept of operations that was heartily endorsed by the senior leadership.

The program was then briefed to the Chief, Army

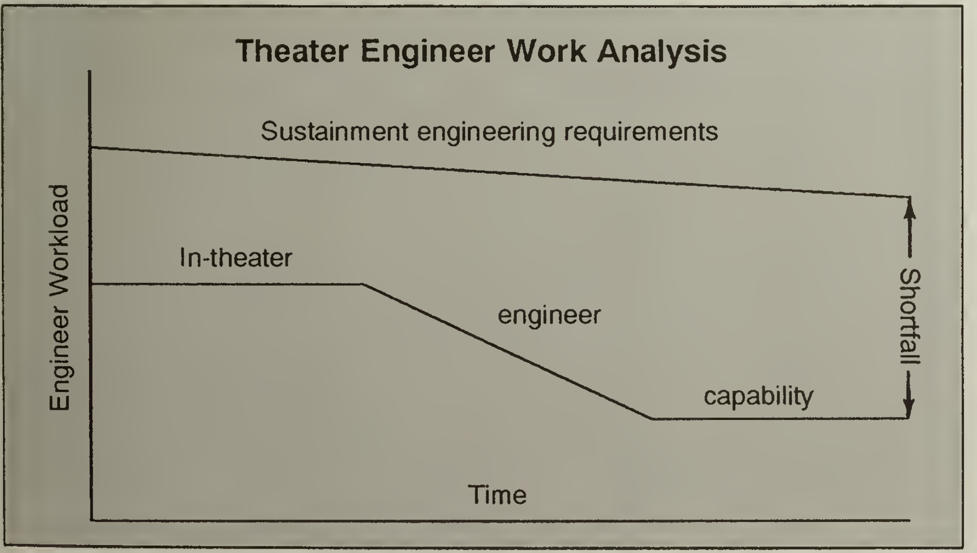


Figure 1

RC Engineer Training and Construction in USAREUR

412th ENCOM Program Phases

Phase I (Prototype) 1993

- Develop and prioritize the 1994 USAREUR RC troop construction list; participate in the Construction Review Committee.
- Manage RC engineer troop construction program at Grafenwoehr and Hohenfels, Germany and at Camp Darby, Italy. (One battalion at Grafenwoehr/Hohenfels, and one battalion at Camp Darby.)

Phase II (Interim) **1994**

- Serve as RC troop construction agent for USAREUR.
- Manage two battalions and two companies at Grafenwoehr/Hohenfels, and one battalion at Camp Darby.

Phase III (Fully Operational) 1995

- Manage four battalions at Grafenwoehr/Hohenfels and one battalion at Camp Darby.

Figure 2

Reserve, who stated that it could serve as the "template" for what the Army Reserve should do in USAREUR. He also committed to maintaining the high levels of overseas deployment training (ODT) funding necessary for program success.

Program Concept

The program will develop in phases over a three-year period beginning in 1993; it will be fully on-line in 1995 (Figure 2). The ultimate goal is to send five or six battalion-sized combat heavy or equivalent engineer units on back-to-back, 3-week annual training rotations to USAREUR during the peak construction months from April through August. The RC engineers will be based primarily at major training areas (MTAs) in Germany (Grafenwoehr and Hohenfels). If required, the engineers can move to support outlying base support battalions (BSBs) and Directorates of Engineering and Housing (DEHs). One battalion will be based in Italy to train with and support the Southern European Task Force.

The engineers' annual training status will cover pay and allowances, ODT funds will cover CONUS to OCONUS and return travel, and the MTAs and BSBs will support the units' housing and messing requirements. Engineer construction equipment initially (1993 and 1994) will be drawn from POMCUS but later will be drawn from engineer equipment parks organized and located to support projects at the MTAs. Construction materials will be funded by USAREUR and drawn by the supported area support group or DEH.

Construction projects that RC engineers will accomplish are designed to provide excellent METL (mission essential task list) training for EAC engineer units (typically combat heavy engineer units) and to alleviate the sustainment engineering and troop construction needs of USAREUR. The mission of a combat heavy engineer unit (company or battalion) at EAC is "to perform construction, maintenance, and rehabilitation of facilities and lines of communication (LOCs) in support of the theater of operations" (FM 5-116, *Engineer Operations: Echelons Above Corps*). Therefore, projects reserved for RC engineers will provide training on the individual and collective skills needed to perform this mission. Both horizontal and vertical construction are included. Some rotations will also have an opportunity to operate under realistic combat conditions in support of maneuver forces. This training will take place in one of the maneuver training boxes at Grafenwoehr's Combat Maneuver Training Center.

Project Proposals, Review, and Selection

Appropriate projects for RC engineer training and construction will be determined by representatives of the 412th ENCOM at USAREUR's annual Construction Review Committee (CRC). The five-member CRC represent USAREUR Deputy Chiefs of Staff Engineer, Operations, Personnel, Resource Management, and Logistics. The committee selects projects to be funded under the Troop Construction Program and assigns them a priority based on CINC priorities and the training value for engineers, as determined by the 130th Engineer Brigade and the 412th Engineer Command.

Development of projects for the Troop Construction Program, of which the 412th ENCOM program forms an important slice, follows a five-step process:

- ASG/DEH develop troop construction project proposals.
- 412th ENCOM/130th Engineer Brigade selects project proposals, based on CINC's troop construction priorities and engineer training value.
- USAREUR CRC develops priority list for project funding.
- DCINC reviews and approves the CRC recommendations.
- USAREUR provides resources for approved projects.

Because more than two years lead time is required to plan and secure slots in the ODT plan, participating RC engineer units are identified well in advance of the selection process outlined above. For example, the 1994 CRC met in June 1993 but the 194th Engineer Brigade (Tennessee National Guard) received the request in November 1992 to perform ODT and troop construction at USAREUR's major training areas in 1994. Similarly, the 411th Engineer Brigade (U.S. Army Reserve) knows that it has the mission in 1995, and the 30th Engineer Brigade (North Carolina National Guard) is planning for operations in 1996. Early identification of engineer construction units meets the program's planning requirements and allows the brigades to send design and construction reconnaissance teams to USAREUR after their projects are selected.

1993 Test

Operation Certain Construction, the test case for the 412th ENCOM program, was successfully completed in September 1993 by the 216th Engineer Battalion, 16th Engineer Brigade, Ohio National Guard. In late March, an advance party of the 216th arrived in theater to draw engineer equipment from the combat equipment concentration site at Pirmasens, Germany for rail shipment to Grafenwoehr. By early April, the first of eight company (-) construction rotations had begun to construct concrete tank turn pads and develop maneuver corridors for the Grafenwoehr and Hohenfels training areas. In June, the engineers of the 216th were joined by the 728th Engineer Utilities Detachment (USAR) from Kentucky. The 728th engineers focused on vertical construction projects. In the process, this training became a total army effort, with Guard and Reserve engineers working and training side-by-side in support of the Active Component soldiers.

By September, the test case was winding down as the 216th completed its projects, turned in equipment, submitted after action reports and lessons learned to the 16th Engineer Brigade and the 412th Engineer Command, and returned to the U.S. The 412th ENCOM staff, however, did not have time to relax. They were deeply involved in preparing for the 1994 RC engineer training and construction cycle and planning for 1995.

The 216th Engineer Battalion improved maneuver corridors and constructed concrete tank turn pads at Grafenwoehr and Hohenfels MTAs during Operation Certain Construction 93.

Lessons Learned

With the completion of the 1993 test case, some lessons will be incorporated in future RC engineer rotations to USAREUR:

- Commanders at all levels must develop sound training plans that maximize the unique opportunities afforded by overseas deployment training and the 412th ENCOM program.
- A selective "slice" of company- and battalion-level command and control and support personnel is required to augment each construction rotation, especially when a rotation is smaller than company size. Command and control cells can resolve problems of coordination and support, thereby allowing smaller construction rotations to focus on work projects.
- The 412th ENCOM must "design for success" by selecting and tailoring projects that can be accomplished within the 18 construction days available to each 22-day ODT rotation. Additionally, they must define to mutual satisfaction the customer and unit expectations about the level of support required, construction standards, and management procedures.
- To ensure continuity of training operations and maintenance activities, select personnel are required for the duration of all construction rotations. These personnel can be provided through the Reserve's Linkup Program, the Guard's Key Personnel Upgrade Program, or through short (179 day) active duty for special work tours.
- Troop construction funding, design development, and design approval cycles must be integrated into the 5-year ODT cycle to achieve coherent program planning.

Conclusion

The 412th ENCOM's RC engineer training and construction program in USAREUR represents a "win-win" situation. By assuming a significant portion of the theater's sustainment engineering requirements, the program directly supports training and quality of life for AC soldiers stationed in Europe. In training RC engineers in a realistic contingency environment, the program enhances the skills and readiness of Reserve and Guard engineers.

Simply stated, the 412th ENCOM program is the best training available for EAC engineers. It includes mobilization, OCONUS deployment, construction, construction management, and reconstitution—exactly what RC engineers will do if called up for contingency or war.

Lieutenant Colonel Jones is professor of Military Science for the Army ROTC program at the University of Texas at Arlington. Previous assignments include 412th ENCOM liaison officer to USAREUR; Chief of Plans and Operations, 412th ENCOM Forward; Commander, HHC, 613th Engineer Battalion (Combat); and platoon leader with the 86th Engineer Battalion (Combat) Land Clearing Team in Vietnam. He has a Ph.D. from the University of Wisconsin-Madison and is a graduate of the Command and General Staff College.

Framing with a Carpenter's Square

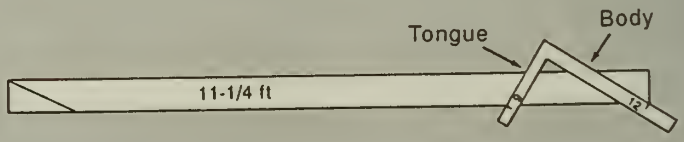
By Sergeant First Class Rick Steward

A carpenter's square (C-square) has several numbered measurements and different scales depending on their use. Three series are manufactured: rafter framing, Eureka standard, and standard. The "face" of the square has the maker's symbol, and the opposite side is the "back." The blade of the "body" is longer and wider than the "tongue" blade, which is shorter and narrow. Let's discuss the rafter framing series.

Rafter framing rules, or explanations, are stamped on the face of the body of the rafter framing square.

To determine the length of the common rafter for a building, use the first line of numbers on the rafter framing C-square, which gives the length for a 1-foot vertical run of the roof. For example, if a roof rises 9 inches to the foot, look directly under 9 (on the first line of the body), and you will see the figure "15.00." Thus, for a 1-foot vertical run, the common rafter length is 15.00 inches.

Assume you are installing rafters in a building that is 18 feet wide. To determine the common rafter run, divide the width of the building in half (18 ÷ 2 = 9). Multiply that number by the common rafter length (9 x 15.00 = 135 inches); convert to feet: (135 ÷ 12 = 11-1/4 feet). That's all there is to it! In this example, the common rafter run is 11-1/4 feet.



To determine the angle on the ends of the rafter (bottom and top ends), use number 12 on the body of the C-square and number 9 on the tongue.

SFC Steward is Vertical Skill Operation/Project NCOIC at the Engineer School.

The following articles are part of an on-going discussion among Army engineers about the operational tenet of synchronization and reflect the complexity of this issue. Comments or articles discussing other synchronization components are welcome.

Synchronization

> *"Synchronization is arranging activities in time and space to mass at the decisive point...Synchronization seeks to gain overwhelming combat power...[It] usually requires explicit coordination among the various units and activities participating in any operation...In a force projection army the ability to synchronize operations becomes paramount." (FM 100-5)*

War Gaming and Synchronizing an Operation

By Major George G. DeMarse

The tactical decision-making process provides the framework for commanders and staffs to plan and formulate tactical plans. It's my opinion that the most critical and most misunderstood step in the process is course of action (COA) analysis and war gaming. This article attempts to answer the following questions: What is the fundamental purpose of war gaming? How is the war-gaming process conducted? And, how do engineers participate?

The Purpose

Observations at the National Training Center indicate that few commanders and staff officers understand the purpose and application of war gaming. Although war gaming involves assessing a course of action's feasibility and other factors (advantages and disadvantages), the brigade staff's primary role in war gaming is to synchronize the capabilities of the brigade. Synchronization is timing. In war gaming, the brigade staff analyzes time and distance as it relates to critical events and battlefield functions.

Current Army doctrine fails to highlight the importance of synchronizing through the war-gaming process. FM 101-5, *Staff Organization and Operations* (under revision), discusses war gaming as part of the commander's estimate of the situation. The word "synchronization" is never used to describe the purpose of war gaming.

At the maneuver brigade level, the brigade engineer is responsible for synchronizing and applying engineer capabilities to achieve the particular effect and outcome expected by the brigade commander. The brigade engineer must analyze the battlefield through time and space to determine when and where to apply the assets that will achieve the commander's desired effect. This is the essence of war gaming.

The Process

War gaming, as the word implies, is a game. In all games, there is some degree of organization and certain parameters and rules. Without an understanding of the rules, teams or individuals normally wander about hopelessly. This often happens when brigade staffs don't understand the rules of war gaming.

Brigade trainers at the National Training Center (NTC) have assimilated a war-gaming process based on many rotations of observing brigade staffs flounder in war gaming. To highlight the importance of organization and synchronization, they have developed a two-step approach. First they assess the feasibility of a COA; then they produce synchronization. This sequence is important.

The first step, called the hasty or initial war game, assesses feasibility through force-ratio analysis. In this step brigade staffs begin to identify critical tasks and events. They cannot synchronize a battle without first identifying the critical events, both friendly and enemy. Many staffs begin to struggle at this point. They assemble to war game but invariably produce a synchronization matrix that only tells a story. They do not produce a precise script that includes detailed timing to achieve the desired effects.

For example, the brigade engineer or his representative may fail to identify a combined arms breaching operation as a critical event. As the staff attempts to war-game and fight the battle, they focus on filling the synchronization matrix with tasks—and neglect the timing aspect of the battle. Consequently, the brigade fails to mass combat power at the decisive point to support the breaching operation. The brigade engineer's problem lies in not identifying the breaching operation as "critical" early in the war-gaming process. This critical event must be identified before he analyzes the force ratios used to determine the forces required to conduct the breach.

The second step, called the detailed or deliberate war game, focuses on synchronizing the capabilities of the brigade. After the staff has completed the initial war game, they present their recommended COA to the commander. Then they conduct a detailed war game based on his decision, as shown on the figure (page 17). They focus on analyzing time and distance to determine when and where combat functions must be applied to achieve the commander's desired results.

In a breaching operation, the brigade staff war-games through detailed actions, reactions, and counteractions. Reverse planning is the doctrinal norm for war-gaming a breach. As the staff war-games from actions on the objective back to the line of departure, a myriad of tasks are synchronized. For example, fire support must be synchronized to determine when and where the artillery must be located to provide the desired effect for suppression, obscuration, or counterfire. The staff predicts when and where actions on the objective will occur. This will determine when and where the breaching operation will take place (point of penetration). The staff also war-games other battlefield functions (such as close air support, air defense, smoke, casualty evacuation assets, military police, and electronic intelligence warfare) to position them at the right place and time to achieve a fully synchronized plan.

Efficient war gaming requires a well trained staff that is intimately familiar with war gaming and group dynamics. To be successful, the staff officers must set aside ego boundaries and function as a group. Staff training must focus on the groups' ability to analyze critical events and predict the timing sequence needed to achieve synchronization.

Engineer Participation

To function effectively in the war-gaming process, the brigade engineer must understand how he participates as a brigade staff officer and how his staff participates and war-games at the battalion level. As the brigade engineer, the battalion commander must understand his role. Moreover, he must understand the roles of other battlefield operating systems (intelligence, maneuver, fire support, air defense, etc.)

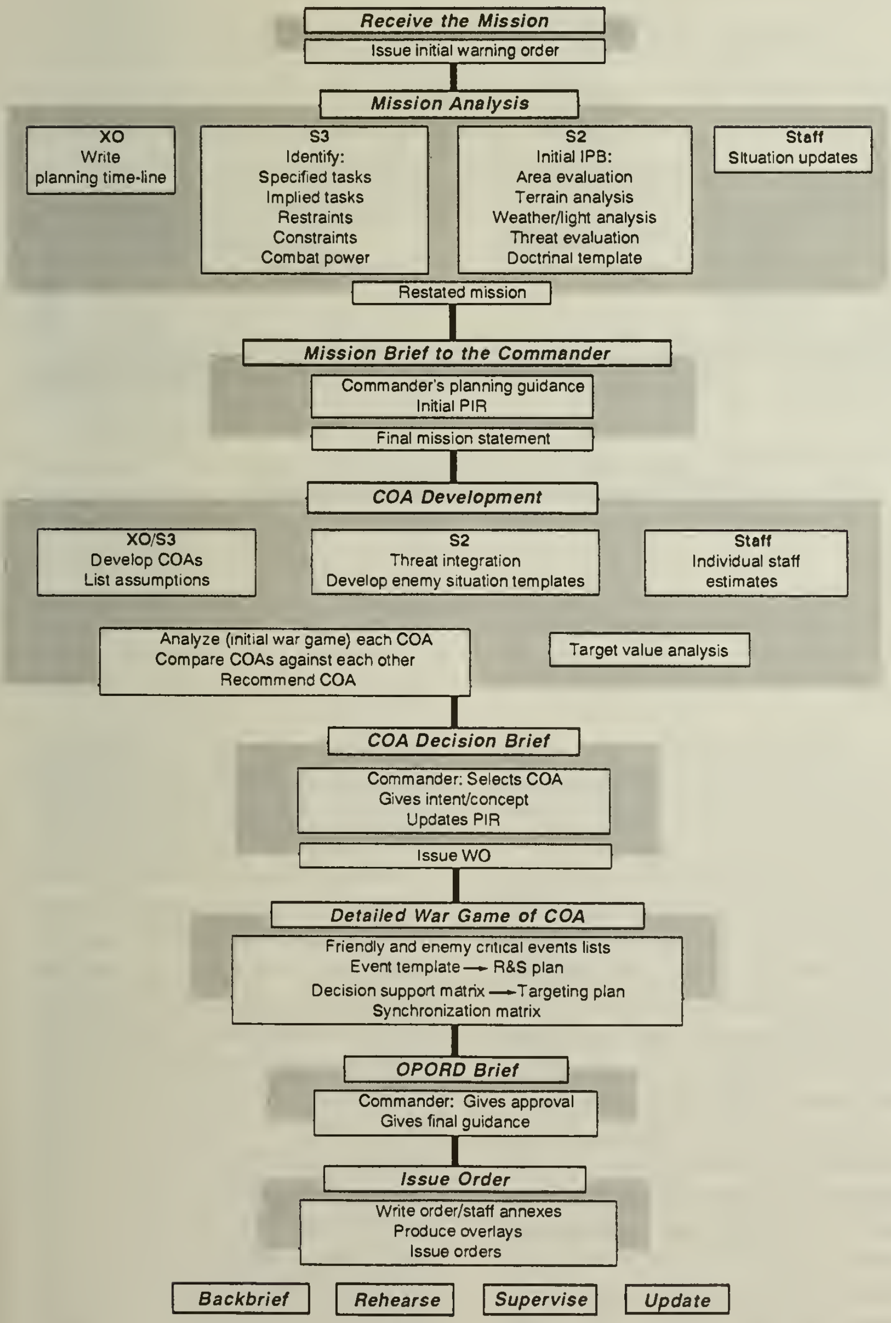
On several occasions, I have observed brigade staffs painfully grind through the war-gaming process. Their heads were not in the ball game. Why? Either they came unprepared for the war-gaming session or the brigade or engineer battalion staffs were inadequately trained. The engineer staff officer needs the right tools before he can effectively participate in the war game. He must thoroughly understand his unit's capabilities. He also needs to know how to best employ his mobility/survivability BOS and how it applies to other BOSs.

The engineer staff officer must not wait until he arrives at the NTC and starts his first planning process to develop EBA products. EBA products to support the war-gaming process should be continuously maintained at the home station. One excellent technique is to develop a battle book that includes all the information needed to war-game, integrate, and synchronize critical tasks. The battle book should include, at a minimum, unit capabilities, time and distance factors, movement rates, and appropriate doctrinal templates. This information should be assembled as it applies to a critical task or event. An appendix in the initial draft of FM 5-71-3, *Brigade Engineer Combat Operations*, includes a checklist that staff officers can also use to develop a battle book.

Doctrinal Needs

The Army needs to develop doctrine that better describes the war-gaming process. Student Text 100-9, *The Tactical Decision-making Process*, a nondoctrinal manual used at Fort Leavenworth, fails to establish a clear picture as to how the war-gaming process is organized and performed. While doctrine writers are now revising FM 101-5, *Command and Control for Commanders and Staff*, the initial draft is mainly a compilation of

Tactical Decision-Making Process



FM 101-5 and ST 100-9. In my opinion, the new manual needs a chapter that describes how war gaming is used to achieve synchronization. The Army needs a method of defining when to assess feasibility and when to synchronize a COA.

The technique taught at the NTC and described in this article is a good start. It clearly highlights the primary role of war gaming—to synchronize the battle and achieve the effects and outcome expected by the commander. It organizes the process so brigade staffs can properly fight the battle and focus on synchronizing critical events on the battlefield.

What Now?

This article is intended to promote interest and generate ideas on how and why engineers conduct the war-gaming process. I believe that our ability to contribute to the success of a battle is related to our capacity to war game and synchronize. Combat engineer tasks, both offensive and defensive, require detailed war gaming to ensure all BOSs are integrated to achieve the desired effect. Remember, synchronization is achieved through detailed war gaming. The timely application of combat power produces the force required to mass and destroy the enemy on any battlefield.

Major George G. DeMarse is currently serving as the Senior Writer/Instructor at the Engineer School. He previously served as a task force engineer trainer and engineer battalion staff trainer at the National Training Center. Other assignments include platoon leader, executive officer, and company commander in the 4th Engineer Battalion, 4th Infantry Division, Fort Carson; and Assistant S3, 23rd Engineer Battalion, 3rd Armored Division. Major DeMarse holds a masters degree in business from Husson College, Bangor, ME and is a graduate of the Command and General Staff College.

Visualizing Mine/Countermine Operations as Part of Synchronization

By Major Keith Kowadlo

The new FM 100-5, *Operations*, states that a major responsibility of commanders is to "visualize" the battlefield in order to formulate concepts of operations needed to accomplish the mission. Embodied in the combat function of battle command, visualizing the battlefield assists commanders with integrating and coordinating combat functions to achieve "synchronization."

As we engineers grapple with the "S" word, we must appreciate that the genesis of synchronization lies in our ability to visualize the battlefield. Visualization includes the ability to "see" the threat and the engineers' response to it. We used to study the Soviet threat exclusively. Today, we must also be able to visualize new, emerging, or unrecognized threats, including the mine warfare threat. Failure to do so can drastically affect combat operations, as the following vignette shows.

The commander is frustrated. Since his entry into the battlefield six days ago, he has been unable to get out and "see" the battlefield as he was accustomed to doing when training back at home station. He is now forced to wait for his vehicular security armada to assemble before he can move because traveling on the main supply routes (MSR) is dangerous.

Things are not going as the commander had planned. His fire and maneuver are not complementary in the traditional sense. There is no enemy at which to fire, and his ability to maneuver is tenuous at best. The resupply convoys frequently run into enemy point minefields, seriously disrupting their ability to logistically sustain the force. The Stinger teams are not being resupplied, which degrades their ability to protect the force's "lifeline"—the flight landing strip (FLS). Mortar rounds and potable water are scarce. Ground MEDEVACS and Class III resupply have slowed down.

Because of the mine threat, the commander orders that no vehicles move at night. He knows the engineers are doing their best to clear the MSRs of the point minefields, but their efforts are not enough. The engineers never know where to concentrate their efforts and the staff does not know how to handle this kind of operation. The commander senses he is losing the initiative; therefore, he begins to divert combat power to the security escorting of convoys. Instead of finding and destroying the enemy, his massive advantage in firepower is now focused on convoy escort! He wonders if anyone appreciates the impact of those point minefields on his force.

> *"Visualizing the battlefield, its threats and our response to those threats, is the starting point for engineers in our endeavor to achieve synchronization."*

Mine/Countermine Operations

In both war and operations other than war, mine/countermine operations pose a great challenge to engineers and commanders. As stated in FM 5-101, *Mobility*, "U.S. forces conduct mobility tasks to obtain and maintain the freedom of both tactical and operational maneuver...Countermine is a subcomponent of mobility that concentrates solely on the actions taken to counteract a mine or minefield through detecting, reducing, or bypassing." Mines have historically posed a formidable threat to modern ground combat forces and will continue to do so in the future.

Mine Threat

The U.S. State Department recently completed a worldwide investigation in which they tasked U.S. Embassies to assess the magnitude of uncleared land mines in their respective countries. Their findings, compiled in a report titled "Hidden Killers—the Global Problem with Uncleared Landmines," estimate there are more than 85 million uncleared landmines in 62 countries. Many of these mines and minefields are unmarked and unrecorded. In future battlefields, the possibility of Army engineers encountering uncleared mines, as well as conducting traditional mine/countermine missions, is great.

One need only watch the nightly news to appreciate the effectiveness with which mines are employed. Easily obtainable on the world market, mines are relatively cheap, easily maintained, and have a long shelf life. They are "on duty" 24 hours a day, require no logistical support, and are indiscriminate killers. Additionally, today's mines are "smarter" than those produced in World War II. Technology enables today's mines to arm themselves, distinguish between targets, and self-destruct if disturbed. As scatterable and off-route mines increase the lethality of the battlefield, they also increase the challenges faced by engineers tasked to clear them.

Mines are clearly a combat multiplier and are likely to remain the poor man's weapon of choice. Our response to this threat depends initially on how effectively we can detect them. How do you conduct a route clearance mission to ensure mobility? To neutralize a mine or minefield (when not under fire) is a relatively straight-forward task if you know where to begin. But first you have to know where! Finding buried mines is a great challenge for engineers.

Mine Detection

The view from my foxhole at the Joint Readiness Training Center (JRTC) is that engineers are not very good at detecting buried mines. We have assets for breaching minefields while under fire but we have relatively few assets for detecting buried mines on MSRs or FLSs. There are four detection methods: visual, physical, electronic, and mechanical. The mechanical method (mine rollers) holds great promise for detecting buried mines on MSRs without tearing up roads in the process. However, mine rollers are seldom considered at the JRTC. Since physical and visual methods are either impractical or overlooked, by default we rely on the electronic method, the hand-held mine detector. This method, however, is slow: Dismounted engineers using mine detectors to conduct route sweeping operations require time (FM 20-32, *Mine/-Countermine Operations*, suggests 1-3 kilometers per hour (km/hr) and 3-5 km/hr for deliberate and hasty sweeps, respectively). Additionally, dismounted soldiers present very lucrative targets.

Based on my experience, engineers and commanders do not appreciate the importance of the mobility mission and usually underestimate the time required for route clearance operations. These activities invariably require more time and assets than staffs allocate, and they can quickly desynchronize a commander's plan. This shortfall is indicative of poor staff planning, resulting from a basic failure to visualize the battlefield. It is my experience that units training at the JRTC do not adequately visualize the battlefield that the JRTC portrays.

The JRTC Environment

The battlefield at the JRTC is nonlinear and closely resembles a Vietnam environment. The JRTC enemy, or OPFOR (opposing force), can be hidden anywhere. Operating in decentralized 3- to 5-man teams, the OPFOR caches their mines and other logistical assets and moves swiftly about the battlefield, attacking when they choose.

The OPFOR can emplace a point minefield (buried) on an MSR in less than 10 minutes. They harrass BLUFOR convoys on the MSRs and use minefields to initiate vehicular ambushes. After their minefield achieves a kill, they reseed it in minutes. Because the OPFOR effectively disrupts unit mobility and forces the BLUFOR engineers to constantly react to them, the BLUFOR engineers are routinely kept off-balance. If the OPFOR "kills" BLUFOR engineers, they emplace additional minefields with impunity. Killing BLUFOR engineers and destroying their equipment (i.e., mine detectors) is important to the OPFOR.

In order for BLUFOR engineers to survive during a route clearance mission, synchronization is necessary at the brigade and battalion task force levels. Synchronization ensures the engineers are provided with the proper intelligence and security assets. This synchronization is rarely achieved however, leaving the engineers in a reaction mode as they haphazardly attempt to clear routes. Rarely are engineers proactive enough to detect and clear minefields before BLUFOR vehicles discover them. It is not uncommon for BLUFOR vehicles to drive directly into a surface-laid minefield, which is indicative of poor mine awareness training.

Consequently, the majority of minefields at the JRTC are cleared the old-fashioned way, one vehicle at a time.

Compounding this is the slow dissemination of OBSTINTEL (obstacle intelligence) regarding the status of mines on the MSRs and the slow reporting of minefields already encountered. This information flow is further hindered by the lack of appropriate battle drills at the brigade and battalion task force TOCs on how to handle reports of minefields.

From my observations of light, combat engineer companies (with mechanized engineer augmentation) during the past 12 rotations at the JRTC, synchronization is the toughest thing for commanders to achieve. The JRTC battlefield, like those at the Army's other combat training centers (CTCs), is as realistic as we can make it. The CTCs force units to fight their toughest fight and work together as part of the combined arms team. In the free-play, force-on-force battlefield of the JRTC, mines are usually the second leading killer and they account for more than one-third of the fratricides.

OPFOR Visualization

The JRTC is a two-sided battlefield with an enemy that also tries to influence the outcome. The enemy understands the importance of visualizing the battlefield. He knows to avoid strength, such as the BLUFOR tanks, because he lacks a direct fire weapon that can defeat the tanks. He knows how to capitalize on weakness, such as the BLUFOR's inability to detect buried mines. Consequently, the OPFOR disrupts mobility by emplacing numerous point minefields (buried) on MSRs because he knows the BLUFOR tankers will think twice before thundering down them. By doing so, the OPFOR not only avoids the BLUFOR strength but at times neutralizes it altogether.

The mine/countermine doctrine in FM 20-32 tells us, "The ability to move forces and material to any point in an area of operations is basic to combat power and often decides the outcome of combat operations."

If the OPFOR determines the mobility of the BLUFOR to be a center of gravity, he will use mines as an economy of force asset to attack it without respite. This technique allows him to wrestle away the initiative and to set or change the terms of battle. By successfully visualizing the battlefield, the OPFOR determines what is important, thus enhancing his ability to prioritize and allocate resources. Accurate visualization allows him to think and act simultaneously in his mission to defeat the BLUFOR.

Battlefield Visualization: A Starting Point

Visualizing the battlefield, its threats and our response to those threats, is the starting point for engineers in our endeavor to achieve synchronization. Only through synchronization will we be successful in our mine/countermine mission. As the ancient Chinese war philosopher Sun Tzu remarked, "What is of supreme importance in war is to attack the enemy's strategy." We engineers must acquire the art of visualizing the battlefield so that we may indeed attack our enemy's strategy, before it attacks us.

Major Kowadlo is the senior engineer observer/controller at the Joint Readiness Training Center. Previous assignments include S3, 37th Engineer Battalion (Combat) (Airborne) and group engineer, 3rd Special Forces Group. He holds a masters degree in civil engineering from Penn State University and is a registered Professional Engineer in North Carolina.

Synchronization Training

By Captain Robert McCarty

The task force S3 briefed the task force commander and his company commanders on the scheme of maneuver. He outlined each one's role in the upcoming defense. The experienced company commanders understood the commander's intent, where his main effort was, and how he wanted to use fire and maneuver to destroy enemy forces. The task force fire support officer highlighted the priority of support and key target numbers. Then, the task force engineer explained the location of obstacle belts, their intents, and the templated enemy force. He asked if there were questions. The commander replied, "Those obstacle belts don't support my intent or the scheme of maneuver the S3 just talked about! Where were you when the staff wargamed and synchronized the plan?"

The Engineer Officer Advanced Course (EOAC) given at the U.S. Army Engineer School, reinforces synchronization and tactical planning with Janus, a battle-focused combat simulation. It is used only as a learning tool and is not a graded EOAC event. The Janus system, named after a Roman god with two faces, can educate the next task force engineer before he is hammered by the task force commander. It shows students where their plan's weak points are when battlefield operating systems (BOS) are not properly synchronized. Janus uses digitized terrain and data models of U.S. and foreign combat and combat support systems stored in its memory to duplicate the effects of those BOS based on the given terrain.

The Engineer School has terrain models for both the National Training Center in California and the area surrounding Fort Leonard Wood. Military and civilian instructors within the school serve as computer operators or "puckers" during a simulation. These puckers can control battalion, company, platoon, or individual vehicles. The students tell the puckers what they want a unit do, and the puckers get it done. The puckers relieve the students of the detailed operation of the system and allow them to concentrate on the main training objectives—understanding synchronization and clear communications.

Plan

The exercise begins with EOAC team leaders giving a brigade orders briefing that covers each major staff function: S2, S3, engineer, and brigade commander. This briefing provides the students with information needed to begin the command estimate process. Team leaders assign students roles in the task force staff, including a commander and an executive officer. They develop a plan with no outside assistance. The staff has representatives from each BOS during the planning phase of this exercise. As a minimum, students must develop an execution matrix and an operation order brief for their subordinate company commanders. Other staff officers develop the written products needed to execute their combat support missions. The S2 prepares a reconnaissance/counterreconnaissance plan, the fire support officer develops target lists, and the engineer develops a time line for a defensive mission.

This practical exercise allows students to focus on the maneuver aspects of planning and executing a task force plan. While not the only learning tool, Janus simulation allows students to quickly determine how successful their plan is. If students do not war-game and synchronize their plan or rock-drill it with subordinates, the lack of planning and preparation will become evident during the simulation. The staff gives the senior team leader, who role-plays as the brigade commander, a back brief before issuing their order. To evaluate how effectively the staff synchronized the plan and how well subordinates understood the plan, another team role-plays that task force. To reinforce the command estimate process and help understand synchronization, the team prepares a company execution matrix. It is used to execute the plan and provide details required by Janus.

Before the company/teams begin planning, the task force staff must ensure the company/teams understand the task force plan. Preparing and using a rock drill/rehearsal site best indicates their understanding. A rock drill also allows commanders and staff to visualize the plan using a model of the area of operations and graphic control measures. The task force members can use this training aid during their brief or have the company/teams use it for their back briefs. At this point in the process, team leaders again stress the importance of synchronization. A 100 percent plan that is 50 percent understood has a 0 percent chance of success; but an 80 percent plan that is 100 percent understood has a 90 percent chance of success.

Prepare

After the task force and the company/teams have completed planning, the exercise moves to the battlefield preparation phase. During this phase, the company/team players enter their part of the plan into the Janus simulation data files. By combining a digitized terrain model of the National Training Center with a computer program that allows checking lines of sight and fields of fire overlaid with weapons ranges, the students get a low-cost but accurate simulation of the ground reconnaissance done by maneuver company commanders.

How closely a student follows the task force plan reflects how well other students communicated their plan. After all company/team plans are entered, the

Photo by Jim Anderson

A civilian "pucker" shows an EOAC international student the locations of units on the flank of his company. Students use this information to ensure their portion of the plan remains synchronized with the task force plan.

Janus system saves them for later execution. Saving this information provides two benefits: protection against a computer malfunction, and the ability to run the plan through multiple iterations if after-action reviews show faulty execution during the battle, not synchronization, caused the mission to fail. After planning and preparation are complete, the execution phase begins.

Execute

Janus provides a realistic simulation of the command, control, and communication problems a task force commander and his staff face during a battle. The staff is in the team room, and the company/teams are "out in the field" in front of the Janus computer screens. With only maps, graphics, and reports from company/team commanders to guide their decisions during battle, the task force quickly grasps the importance of clearly communicating the intent and properly synchronizing all BOS assets. The task force also learns the importance of the tactical operations center (TOC). If the task force does not correctly track the battle by posting enemy losses, friendly losses, and other key events, such as a chemical strike or execution of family of scatterable mines (FASCAM) targets, they have no information on which to base decisions identified during the planning process as critical to mission success.

While the commander or S3 may be forward, he usually cannot see the entire battlefield. The commander depends on his staff to collect reports from the company/teams, analyze them to determine enemy intentions, and recommend the best course of action. The staff cannot do its job if the company/teams do not report critical information.

The second team of students (serving as company commanders, fire support teams, and direct support artillery) is linked to the team room TOC by two primary methods of communication . The main method is hand-held, two-way radios that provide realistic battle sounds with squelch and many requests for "say again all after." Telephone lines provide backup communications for command nets because few radios are available. Telephones also serve as the primary means of relaying intelligence information and requesting indirect fire support. The two communications systems replicate the delays associated with observing an enemy target and having steel hit that target.

While observing a computer screen, the company commander or his fire support team radios the TOC to report enemy locations and request fire. The TOC then telephones the direct support artillery student, who is sitting at a separate screen. With multiple sitings, reports, and fire missions coming in, the TOC can and will miss some information or key events. Team leaders, who serve as observers/controllers, capture the missed opportunities, lost information, and sound decisions made at critical times. They report their findings in the most important phase of this training event the after-action review.

After-Action Review

Team leaders document their observations in the after-action review format described in Training Circular 25-20. After giving an overview of the training objectives and the brigade intent, team leaders discuss what happened during the planning, preparation, and execution phases of the exercise. They stress operation order preparation and synchronization. Borrowing a technique from the National Training Center, opposing force players from the threat office also discuss their plan. Team leaders then lead students in a discussion on what happened, using BOS and what they saw in their roles as staff officers or company commanders. Students describe their training in terms of what they would sustain and what they would improve.

At the end of the exercise, students use their perspective and the team leaders' observations to develop lessons learned. Some Janus simulations have shown that students at both company and task force levels tend to fixate on the close fight of a company or platoon, forget to report information, or fail to track the battle. These shortcomings result in missed decision points for disengagement, fired FASCAM targets, or the late arrival of reserves. Synchronization is the common thread throughout the after-action reviews.

Lessons Learned

The valuable lessons learned in the after-action review provide new task force engineers with a better understanding of synchronization and tactical planning. As a result, they are better able to provide support to the task force commander and his staff as well as to their parent engineer battalions. By using the Janus computer simulation as a training tool, students see what really happens when BOS are not properly synchronized.

Captain McCarty is a team leader with the EOAC at Fort Leonard Wood. He previously served as a company commander and brigade engineer with the 7th Engineer Battalion at Fort Polk, Louisiana. Other assignments include tours with the 14th Engineer Battalion, Fort Ord, California, and the Huntington and Pittsburgh Engineer Districts. A graduate of the Engineer Officer Basic and Advanced Courses, Combined Arms and Service Staff School, and Command and General Staff College, he holds a bachelor's degree in construction management from Auburn University.

Green-to-Gold:

Future Officers From Today's Enlisted

By Captain Greg Lane

In a constant search for quality officer material, the Army taps into its enlisted ranks to find good soldiers with the potential to be officers. These soldiers have three possible routes to gain a commission: Officers Candidate School at Fort Benning, U.S. Military Academy at West Point, or Army Reserve Officers Training Corps (ROTC) offered on approximately 300 college campuses nationwide. This article focuses on the ROTC option, specifically the Green-to-Gold program.

Green-to-Gold is the Army ROTC program that offers soldiers who are currently on active duty an early discharge under Chapter 16, Army Regulation 635-200, to earn a bachelor's degree and an officer's commission. The soldier is discharged and attends college, taking courses dictated by the academic major of the soldier and Army ROTC courses. He or she is commissioned upon graduation with a bachelor's degree.

Soldiers in engineer military occupational skills make excellent Green-to-Gold candidates. Many of these soldiers already know the small unit tactics and basic soldier skills that are key in the Army ROTC competitive evaluation process. Additionally, many have some college experience, specialized training that can transfer to college credit, and good GT scores. Soldiers with good high school records and/or some college credit may meet the qualifications for Green-to-Gold.

Two options are available: scholarship and nonscholarship. Selection for a scholarship is competitive and is

Cadets James Hallmark (left) and James Hondura (right), formerly sergeants at Fort Campbell, exchange instructions during a field training exercise. Cadet Hondura formerly served as a 12B combat engineer.

	Scholarship		Nonscholarship
	Four-Year	Two- and Three-Year	
Requirements	• Have less than 14 semester hours of college work. • Have an SAT score of at least 850 or an ACT score of at least 19. • Be accepted by an historically black college or university offering Army ROTC. • Be accepted by the Army ROTC department at that school. • Have at least two years of active duty when discharged to start college. • Be recommended by both the company commander and a field grade officer. • Be no older than 26 on June 30 of the year of graduation with two years of active duty, 27 with three years of active duty, or 28 with four or more years of active duty. • Pass a medical examination.	• Have a GT score of 115 or higher. • Have a college grade point average (GPA) of 2.5 or higher. • Be accepted by any school offering Army ROTC. • Be accepted by the Army ROTC department at that school. • Have a least two years of active duty when discharged to start college. • Be recommended by both the company commander and a field grade officer. • Be no older than 26 on June 30 of the year of graduation with two years of active duty, 27 with three years of active duty, or 28 with four or more years of active duty. • Pass a medical examination.	• Have two years of college already completed (at least 54 semester hours). • Have a GT score of 110 or higher. • Have a college GPA of 2.0 or higher. • Be accepted by any school offering Army ROTC and be accepted by the Army ROTC department at that school. • Have at least two years of active duty when discharged to start college. • Be recommended by the company commander. • Be no older than 29 at graduation (waiverable to 32). • Pass a medical examination.
Benefits	• Tuition completely paid up to $8,000 per school year. If tuition is higher than $8,000, the Army pays $8,000 or 80 percent, whichever is greater. • Book allowance of $225 per semester or $150 per quarter. • Monthly subsistence allowance of $100 during the school year.		• Monthly subsistence allowance of $100 during the school year. • The opportunity to simultaneously serve in a National Guard or Army Reserve unit while a cadet, drawing E5 pay as per time in service.

based on the number of qualified applicants and the number of scholarships available. To qualify, a soldier must meet the criteria in the table above.

Soldiers can draw their veterans benefits while in Army ROTC if they have served the minimum time to qualify. For the Montgomery GI Bill, soldiers must serve at least 30 months of a three or more year enlistment to qualify. If the soldier has the Army College Fund as well, he qualifies for that money; however, the money is prorated to the percentage of the enlistment he has served.

If a soldier wants a scholarship and is qualified, what are his chances? In the last five years (FY 89 to FY 93), a soldier's chances have been excellent. In four of those years (FY 90 being the exception), every qualified soldier who applied got a scholarship. If a soldier is qualified, he or she should apply!

The service obligation is eight years after commissioning. This time can be served on active duty (if selected), in the National Guard, or in the Army Reserve. Historically, half the ROTC graduates go on active duty, and the other half go to the National Guard or Army Reserve.

Though my experience is limited to being Fort Campbell's Green-to-Gold program representative and a member of Austin Peay State University (APSU) Army ROTC department, I have seen great success in this program. Green-to-Gold cadets at Austin Peay do very well (one, CPT Lance Richardson, was the top cadet in the nation in 1989), and they provide maturity and a breadth of experience to our ROTC program. They helped us become the top-rated, medium-sized Army ROTC program in the nation in 1990. Green-to-Gold cadets are in demand at every school that has an opportunity to see what they can do.

If you or any of your soldiers are interested in the Green-to-Gold program, contact the Army ROTC department nearest you for information and assistance. Each stateside installation (to include Alaska and Hawaii) have nearby Army ROTC departments with responsibility for providing Green-to-Gold coverage to that installation. If you are overseas, contact your nearest education center and the Army ROTC department of your school of choice for assistance.

Captain Greg Lane is an infantry reserve officer attached to the Army ROTC department at APSU. He previously served 12 years on active duty, including tours at Fort Campbell, Korea, Fort Polk, and APSU Army ROTC. At Fort Polk, he commanded Company E, 3rd Battalion, 6th Infantry Regiment, and HHC, 2nd Brigade, 5th Infantry Division (Mechanized). He is a 1981 graduate of The Citadel.

LESSONS LEARNED:

Midwest Flood of 1993

By Vern Lowrey

The following Lessons Learned address military disaster relief operations during the massive flooding that occurred in the midwestern United States in 1993. Response to this crisis revealed important lessons in Army preparedness, leadership, organization, equipment and safety. For more information write to Commandant, U.S. Army Engineer School, ATTN: ATSE-ESA, Fort Leonard Wood, MO, 65473-6630. Or call (314) 563-4007, DSN 676-4007.

* * *

INTRODUCTION. A flood has been described as a "disaster in slow-motion." This was certainly true for the 1993 flood in the midwestern United States, which began in February and continues as this article is written (November 1993). Military campaigns were fought over 2000 miles of rivers in Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. Series of battles were fought along individual stretches of the Des Moines, Illinois, Mississippi, Missouri, and numerous other rivers, streams, and lakes.

Unlike the damage resulting from a hurricane, earthquake, or tornado, the flood damage was not localized or quickly assessed and then remedied by the rapid reaction of state and federal agencies. Instead, the military response was built gradually: It started at the local level, moved to state levels (including the National Guard), and finally moved through the federal level (including active and reserve forces and the U.S. Army Corps of Engineers) as capabilities to fight and recover from the flood were exhausted. Joint operations were conducted between Air and Army National Guard forces as well as with the Coast Guard. Based on this experience, the current doctrine in FM 100-19, *Domestic Support Operations,* appears to be sound in guiding military flood-relief operations. The following topics were identified as key observations.

TOPIC: **The military command estimate process.**

DISCUSSION: The framework of the military command estimate process was used by all National Guard (NG) and U.S. Army Corps of Engineers (USACE) headquarters personnel. Intelligence information was continually gathered concerning the terrain, levees, flood levels, and weather. Current information concerning the employment of local, state, and federal resources was also gathered. Based on this information, military agency staffs and commanders developed courses of action for flood-fighting and flood-recovery operations. Decisions were reached and implemented as required.

RECOMMENDATION: Continue to use the military command estimate process during disaster-relief training and operations.

TOPIC: **Previous flood-relief operations and disaster-relief training exercises.**

DISCUSSION: Flood-relief operations early in 1993 provided valuable insights and helped foster coordination for responses to flooding that occurred later in the year. All operations prior to the major flooding events in July and August helped establish and improve liaison with local authorities. Army and Air National Guard, Active Army, and USACE personnel had previously participated in joint disaster relief exercises with Federal Emergency Management Agency (FEMA) personnel and local authorities. Although these exercises revolved around various scenarios including earthquake, nuclear power plant evacuation, and civil disturbance responses, they helped establish lines of coordination between military response forces and civilian agencies.

RECOMMENDATION: National Guard, Active Army, and USACE personnel continue to participate in joint exercises as resources and time allow.

TOPIC: **Liaison teams.**

DISCUSSION: All agencies involved in the midwest flood response effort were unanimous in the need for effective liaison personnel at emergency operations centers (EOC), from the local/county/city level to the FEMA level. Liaison personnel often were called upon to make immediate, on-the-spot decisions concerning military capabilities within the intent of the military response plan. They were considered subject matter experts (SME) but lacked training to be SME. Liaison personnel required dedicated communications and transportation capabilities.

RECOMMENDATION: Military response agencies provide trained, competent liaison personnel with equipment who can coordinate and represent their interests. Allow liaison personnel to make on-the-spot decisions based on the intent of the military response plan and the commander's guidance.

TOPIC: **Rules of engagement (ROE).**

DISCUSSION: The presence of National Guard forces in flooded areas normally provided a sense of secure calm to the local population, negating the need to demonstrate a show of force with weapons. Illinois, Iowa, and Missouri National Guard personnel were not issued weapons or ammunition based on this premise. Missouri authorized the issue of weapons for security missions when local authorities requested personnel to augment their police capabilities. Kansas National Guard personnel drew weapons for local security operations. All personnel were thoroughly briefed on the ROE and carried ROE cards. These ROE followed standard procedures identified for civil disturbance operations.

RECOMMENDATION: Continually assess the need for weapons and ammunition during disaster relief operations. When weapons and ammunition are required for security operations, use standard ROE, including rules of deadly force. Thoroughly brief personnel on the ROE and issue ROE cards.

TOPIC: **Release of National Guard forces from flood-fighting locations.**

DISCUSSION: National Guard forces initially were called to assist with immediate efforts to prevent loss of life, assist with evacuations, and provide security to evacuated areas. The goal was to have them stay only until local authorities could take over the flood recovery efforts. This goal allowed the NG units to be deactivated or quickly moved to other locations. Determination of when local authorities could relieve them was done by mutual agreement (consensus) between local officials and NG commanders. A common technique was to tie their release to a measurable event such as river depth, opening of a road or bridge, etc.

Sometimes it was difficult to get local authorities to realize that they had the capability to continue flood recovery efforts without NG assistance. Local people wanted the National Guard to continue to patrol evacuated areas because they perceived the areas would be "less safe" after these forces left. Release actions were not fully announced in some cases, which made it difficult for local authorities to quickly cover the lost capability.

RECOMMENDATION: Use measurable events to establish release criteria with local authorities as soon as possible. Continually communicate with local authorities concerning release actions.

TOPIC: **Communications equipment.**

DISCUSSION: Various kinds of communications equipment were required during the flood-relief operations. Cellular telephones were used extensively by USACE and National Guard personnel except in a few areas not covered by cellular telephone towers. While several types of cellular phones were procured or donated, those with higher wattage capability did the best because they had a larger coverage area. Personnel required training on how to use these phones, including how to periodically recharge and replace the batteries. Spot shortages of batteries occurred. Each military response agency controlled their own telephone frequencies. Fax machines were provided down to the task force level. They effectively provided up-to-date logistics and personnel status information. Both fax machines and E-MAIL were used extensively to transmit activation and deactivation orders. Radio coverage was provided by high frequency (HF), single-sideband type of equipment. Local FM radio coverage was provided primarily by AN/PRC-127 and AN/VRC-12 equipment.

RECOMMENDATION: Continually assess communications requirements, including existing cellular telephone capability and impacts of potential damage to existing towers. Procure or plan to procure cellular telephones with additional batteries for contingencies. Provide each liaison officer with a cellular phone. Provide needed cellular phone training. Coordinate frequency requirements with local agencies. Provide fax machines and E-MAIL capability to the task force level. Continue to use FM and HF radios for back-up communications.

TOPIC: **Maps.**

DISCUSSION: Map coverage appeared adequate to support military response efforts in flooded areas. The USGS map scales used were primarily 1:100,000 and 1:24,000. Locally produced maps included city street maps, and county and state highway maps of varying scales. USACE Flood Plain maps were used primarily along the Mississippi River basin. Some local maps were outdated and did not show recent streets or roads. No difficulties in interpreting the maps were noted. The large-scale maps were used primarily in Emergency Operations Centers, while the small-scale maps were used by units and personnel on the ground.

RECOMMENDATION: Continually assess, acquire copies of, and train with updated map products for potential disaster relief operations areas.

TOPIC: **National Guard logistics support.**

DISCUSSION: National Guard units that deployed with all organic equipment, supplies, and repair parts were immediately capable of extended operations in the flood-relief effort. Other units that deployed without all organic equipment, supplies, and repair parts had to rely on local supply sources and local transportation. They were not fully capable to fight the floods. In states where individuals instead of units were called up, logistics support problems were compounded even further. States that provided forward direct support (DS) maintenance contact teams from organizational maintenance support (OMS) shops could repair most equipment on-site and had minimal down time. States that retained DS capability at their own OMS shops provided less timely repairs. Most units provided effective preventative maintenance (PM). Because vehicles were continually driving in and around water, PM was heightened, especially maintenance to keep fluids and seals from being contaminated. Additionally, portable latrines were needed in many areas for field sanitation purposes, and refrigerated vans were needed to store rations. Personnel required large quantities of sunscreen, bug repellent, flashlights and flashlight batteries.

RECOMMENDATION: Take all organic equipment, supplies, and repair parts when responding to disaster-relief missions. Provide forward DS maintenance capability and schedule PM operations throughout the operation. Provide portable latrines, refrigeration equipment, and adequate stocks of individual supplies, based on the situation.

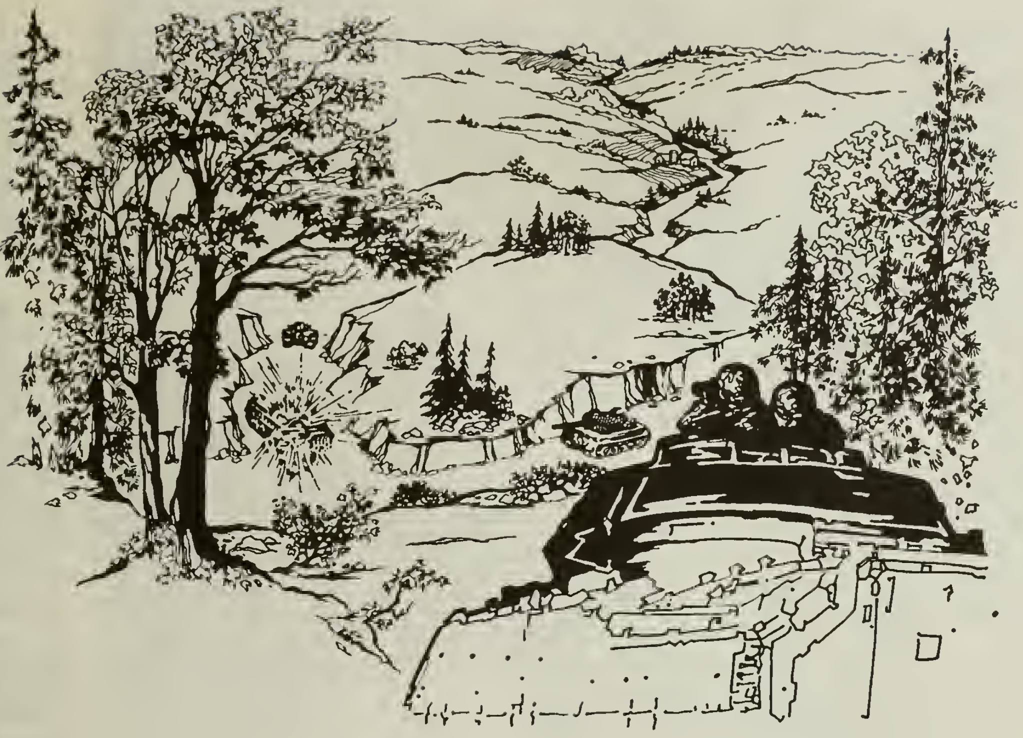
TOPIC: **Safety.**

DISCUSSION: To keep personnel safe, commanders used the risk assessment process throughout the flood-relief effort. Safety concerns centered around prevention of heat injuries, night operations, use of life jackets, and protection against tetanus and insect bites. All personnel received training on how to spot and treat heat-related injuries. Although temperatures reached 100 degrees Fahrenheit in some areas with high humidities over 80 percent, very few heat related injuries were reported. Personnel were continually hydrated with water, used sun screens, and used the buddy system to watch each other.

Military personnel and equipment needed to be easily visible in the dark because operations continued around the clock. Floodlights provided by USACE and the Air National Guard were used extensively in critical flood-fighting areas. Several traffic accidents occurred when military vehicles with camouflage paint were not visible at night. This military equipment required additional reflective devices such as highway warning lights to prevent cars from driving into them. Personnel working at night were required to wear reflective clothing and use flashlights and the buddy system. Agencies required that all personnel operating on levees and in and around water wear life jackets. The life jackets provided by USACE to the National Guard and other agencies saved several persons who were swept away when levees broke. Additionally, all military personnel received inoculations against tetanus because of the unsanitary water. Adequate stocks of insect repellent were available to ward off mosquitos and flies around flooded areas.

RECOMMENDATION: Continually stress safety during disaster relief operations, including operating at night. Use the risk-assessment process. Plan for specific safety requirements such as the need for life jackets and highway warning equipment.

Mr. Lowrey is Chief, Analysis Division, Directorate of Evaluation and Standardization, U.S. Army Engineer School. He served as the subject matter expert for the Center for Army Lessons Learned during the midwest flood disaster-relief effort.



Counterreconnaissance and Obstacle Integration

By Captain Kevin Woods

The scout platoon leader calls the task force tactical operations center to let them know enemy reconnaissance elements are penetrating the screen unseen. He can give only general locations. Moving slowly and often dismounted, the enemy has a distinct advantage in these rolling hills with random patches of dense trees, deep draws and numerous trails. The terrain's multiple routes through slow-go areas and concealed vantage points make overlapping surveillance impossible. The armored task force, planning a defense-in-sector mission, is counting on the success of the counterrecon fight.

The scouts have organized into three observation posts along the designated screen line 5 kilometers in front of the main body. Their mission is to provide early warning to the task force, harass the enemy with supporting indirect fire, and (with the help of two supporting tank platoons) destroy enemy reconnaissance elements within their capability. As the morning light arrives, the frustrated counterrecon element knows it has been unsuccessful—the main body will pay the price.

Lessons from our combat training centers continually reflect the strong correlation between successful security operations and tactical success. This article describes the need for supporting security operations with obstacles and recommends techniques for obstacle employment.

Most commanders agree on the need for strong, successful counterreconnaissance. Deny the enemy intelligence—that's the objective. Unfortunately, when task organizing the counterrecon force, planners routinely minimize the mobility/survivability (M/S) battlefield operating system (BOS) that can enhance their chance for success. Maneuver and engineer leaders seldom task organize engineers to support the counterrecon mission with countermobility assets. Two common reasons for neglecting this BOS are: Engineer work in the main battle area (MBA) has a higher priority, and obstacles in the security area will limit freedom of maneuver and thus have no place in a mobile, aggressive counterrecon plan. Both reasons are flawed but merit some analysis.

Photo by Elizabeth Wessels

Engineer squad leader coordinates with scouts to ensure obstacles are integrated into the counterreconnaissance plan.

Prioritizing Obstacle Effort

Countermobility (CM) work in the MBA has a high priority but because of stale, "same-same" thinking, too often the MBA becomes the only area where CM work is planned and obstacles are emplaced. The decision to use or not to use obstacles in the security area should be based on the maneuver commander's intent. Many maneuver commanders, however, are unfamiliar with the benefits possible when engineers integrate CM into the counterrecon plan and thus fail to task organize for it.

Omitting CM in the security area in favor of engineer work in the MBA will not necessarily result in a greater CM effect in the MBA. Although engineer effort in the security area reduces the quantity of resources available for the MBA, these two areas are not mutually exclusive. This is because obstacles in the security area enhance the effectiveness of the counterrecon fight and protect the integrity and effects of obstacles in the MBA.

For example, if obstacles in the MBA are observed, reported or prebreached by the enemy because of ineffective counterrecon, the effort spent on the MBA obstacles has been seriously diluted. Once compromised, obstacle surprise as well as much of their potential effects are lost. Battles at the National Training Center have shown that if the counterrecon battle is lost, the opposing force usually wins and rarely breaches or loses a vehicle in any obstacle.

For the task force engineer, the engineer estimate process is the best tool to ensure that the maneuver commander understands and plans for all mission requirements. When conducting the engineer estimate, the task force engineer should analyze the maneuver course of action for all engineer requirements. Once he understands the requirements for CM in the security area, he can allocate capabilities and war-game to determine work priorities. This process balances obstacle efforts between the MBA and the security area to best support the overall maneuver plan.

Mobility within the Security Area

Do obstacles in the security area reduce friendly freedom of maneuver? They can and will—unless the obstacle plan is integrated with maneuver and obstacle emplacement is directly coordinated. Integration begins with the engineer estimate; continues through the critical, on-the-ground coordination conducted between emplacing engineers and responsible counterrecon elements; and ends when the unit completes accurate recording, reporting and dissemination of obstacle locations.

Units must emplace obstacles in the security area as early as possible to make them useful. Because of limited time and the flexible nature of the fight, the counterrecon commander usually plans and refines much of the fight at his level. Consequently, the task force engineer (and the task force staff) may not be fully capable of accurately planning obstacle groups to support the counterrecon fight. By using the engineer estimate, however, the task force engineer can pass necessary and valuable information to the engineer element that supports the counterrecon force. He should pass information as it becomes available rather than hold it for dissemination through a formal operation order.

An event template reflecting the limit of enemy advance (LOEA) is especially useful in planning counterrecon obstacles. The LOEA is a result of terrain and weather analysis to determine the point at which the enemy can observe friendly positions. This limit is usually a function of line of sight and should include enemy observation capabilities (such as infrared, thermal and telescopic). In essence, the counterrecon plan is tailored to prevent the enemy from going beyond this limit.

The standard obstacle effects are: *disrupt, turn, fix and block.* These effects provide a common language when referring to an obstacle's desired impact. They do not dictate the design of an individual obstacle. The emplacing unit, in coordination with the covering element, is responsible for designing obstacles to elicit a desired effect. Thus, the character of obstacles in the security area will normally differ from those in the MBA because of differences in the mission and the capability of enemy recon units and enemy main body elements.

The enemy recon element's mission is to gather or confirm intelligence while remaining undetected. To remain undetected, they will report and bypass any obstacles they encounter. Friendly units must not make the mistake of thinking enemy recon elements will use the same avenues of approach as the enemy main body or that friendly unit boundaries are relevant to them. As a rule, the more concealment or protection a route provides, the more likely enemy recon elements are to use it. This implies that security area obstacles will normally require less time, manpower and materials than MBA obstacles.

Obstacle Placement in the Security Area

Individual obstacles in support of the counterrecon fight have the capacity to harass, deceive, delay, divert or deny access to the enemy. Moreover, they can function as an alert or early warning mechanism. In the security area, these obstacles fall into three general categories: obstacles forward of the screen line's general trace, obstacles within the screen, and obstacles behind the screen in support of the guard force.

Forward of the Screen

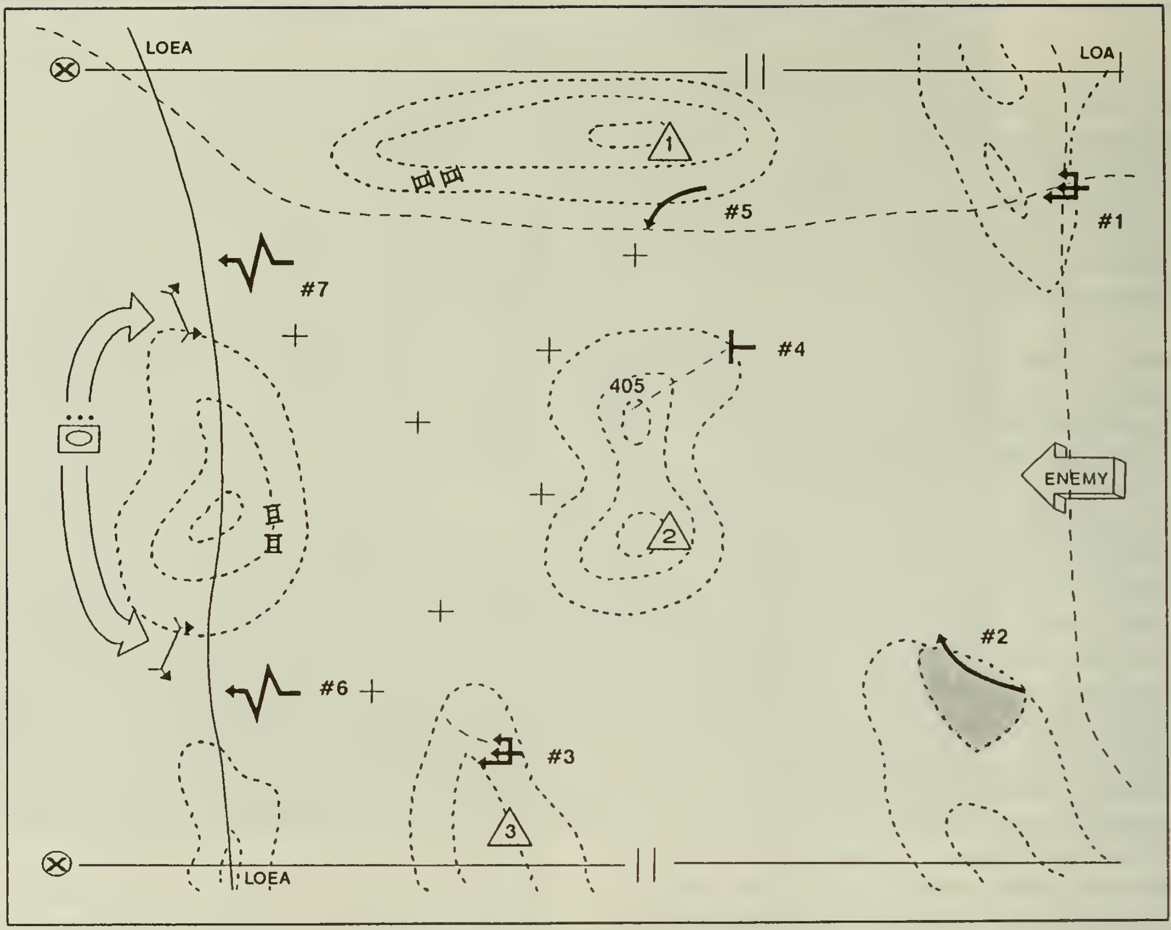
For a screen mission, combat forces are not normally arrayed to mass fires, but obstacle theory does not change. Closest to the enemy are obstacles well to the front of the screen and sometimes beyond surveillance. Obstacles in these forward locations serve to immediately slow, caution and deceive enemy recon elements.

Units planning obstacles in this area should place them as far forward as feasible and on terrain likely to be traveled, such as defiles or road intersections. The limit of advance typically restricts how far forward units can emplace them. Because enemy recon elements will probably bypass obstacles (but will report them), obstacles in front of the screen should focus on frontage rather than depth or density. Since time is limited and most security area obstacles do not need to surprise or kill, surface-laid mines are the norm.

Obstacles forward of the screen serve a useful purpose, but operations this far forward are risky. When working in this area, stealth is the best means of security. Dismounted movement is usually necessary.

Commanders must understand that obstacles in this area may not be seen and integrated with fires, but they will still produce the desired effect of slowing, cautioning and deceiving enemy reconnaissance elements. This concept conflicts with conventional wisdom, which holds that an

> "...It is the synergy of the close combat triad—terrain/obstacles, fires, and maneuver—that will ultimately determine the enemy's response."



Obstacle placement in the security area

obstacle not covered by fire is ineffective.

In the figure above, the engineer emplaced two obstacles forward of the screen:

Obstacle 1 is on a dirt road intersection, 2 kilometers in front of OP1. The intersection and obstacle are not observable by the observation posts (OPs). The obstacle is an easily detected point minefield consisting of 10 mines. The engineer selected this location because the terrain flows naturally through this point and the likelihood of use by the enemy is high. The desired effect is to disrupt or slow the enemy by forcing increased vigilance. Enemy reconnaissance elements will report this obstacle, and in doing so, inadvertently add it to their decision-making process.

Obstacle 2 is also well forward of the screen. It consists of three modular pack mine system (MOPMS) minefields emplaced to discourage movement on terrain that OP2 and OP3 cannot see. With a width of approximately 70 meters per dispenser, the engineer positioned the MOPMS minefield so that it borders the masked area but can be observed by the scouts. When choosing to use MOPMS, the engineer had to consider the technical limitations that make them a poor choice for some missions. MOPMS have a self-destruct time of 4 hours with three reset options, for a maximum of 16 hours. A soldier must be within 300 to 1,000 meters to remotely reset MOPMS.

Within the Screen

Obstacles emplaced as part of the screen line help maintain the usual nonpermeable intent of the screen. Therefore, units generally emplace these obstacles in areas the screen force identifies as vulnerable. Deadspace within overlapping surveillance and routes leading to vantage points are common locations. Going with the adage "if it can be seen, it can be killed," engineers should emplace obstacles in this area to help the screen force "see" the enemy. Obstacles that alert (such as booby traps and trip wires) are especially applicable. These obstacles typically require fewer resources but more ingenuity.

Obstacle 3 is a simple trip wire connected to an antitank mine. The engineer placed it on a combat trail leading over a heavily wooded ridge because OP3 considered this trail a hole within the screen. The trip wire serves to alert OP3 as well as the guard force.

Obstacle 4 is composed of concertina wire and a point minefield. It blocks the road leading to the top of hill 405, which is a significant vantage point offering good all-around observation. The wire consists of two 25-meter rows of concertina, and the point minefield includes 15 antipersonnel mines with trip wires.

Behind the screen

Units should emplace obstacles behind the forward trace to reinforce the depth of the screen. This is where the guard element will destroy enemy reconnaissance vehicles with direct-fire weapon systems. Obstacles in this area help shape engagement areas and buy time for tactical repositioning.

To be effective, these obstacles must be integrated into the guard force fire plan. Because the guard force mission must remain flexible to cover a wide area with sufficient combat power, the initial fire plan is likely to change. To the maneuver unit, changing the fire plan means shifting vehicle and soldier locations. To the engineer it means shifting obstacles. Therein lies the challenge: The engineer must maximize the use of available time to emplace obstacles, but he must not waste resources emplacing obstacles that will not support the changed fire plan. There is no simple solution to this difficulty, but two suggestions can minimize the problem:

- Give the guard force commander time to establish his plan by focusing initial CM efforts forward of and within the screen.
- Ask the guard force commander for the information needed to integrate the CM plan as soon as possible. You must aggressively seek this essential information. The initial engineer requirement is usually "where does the guard force commander want to kill the enemy?" Knowing this, the engineer can begin to focus the guard force CM plan. The guard force commander's intent will determine the intent of the obstacle group (block, turn, fix, disrupt). The engineer will design an obstacle that supports the commander's desired effect, but it is the synergy of the close combat triad—terrain/obstacles, fires, and maneuver—that will ultimately determine the enemy's response.

The counterrecon mission may have many diverse CM requirements, and decentralized engineer execution is the best method to support them. Decentralized execution of the CM effort in the security area means that engineer squads must work independently and maneuver units must develop Class IV and V (mines) basic loads. Engineer squads should be free to coordinate directly with OPs. If it is a platoon effort, this direct coordination will physically free the engineer platoon leader to develop the guard force obstacle plan.

Obstacle 5 is a two-row minefield. The desired effect is to turn the enemy away from the tree line along the ridge and into the open, planned engagement area.

Obstacles 6 and 7 are designed to fix reconnaissance elements, thereby giving the reserve tank platoon additional time to move into the attack-by-fire positions. Both groups consist of four 50-meter, two-row minefields. Target reference points on the ground, as well as direct communication between the obstacle-emplacing element (the engineer platoon) and the overwatching guard element, ensure the obstacles are integrated with the fire plan. These two fixing groups may also act as disrupting groups if encountered by the enemy main body.

Total engineer effort in the security area in this example is 12 hours. In his company operation order, the engineer company commander directs the platoon leader to stop work at a set time, brief the counterrecon commander on all completed work and conduct a coordinated movement back to the MBA along a designated lane and passage point. Upon arrival back in the MBA, the engineer platoon continues to emplace obstacles in support of the task force's main body.

The Payoff

Engineer units can increase their effectiveness by establishing a normal association with the scouts and training this method of obstacle integration with them. Units should be capable of conducting CM work in the security area with either squad- or platoon-sized elements and should train for both. Once understood, the payoff for providing countermobility effort in the security area can be significant.

The counterrecon fight is often the most important phase of the defense. Planning CM to support it must not be routinely ignored. Both historical examples and the experience of today's combat training centers clearly show that where engineers concentrate and bring their talents to bear, success follows. The counterrecon fight demands that engineers unleash their versatility and look beyond the forward edge of the battle area in applying their talents.

Captain Kevin Woods is currently assigned to the U.S. Army Engineer School as a small group instructor for the Engineer Officer Advanced Course. Previous assignments include commander, 58th Engineer Company, 11th ACR, Germany; and commander, D/1 Engineer Company, 1st ID (Forward), Germany. He is a 1983 ROTC graduate of Westmont College.

Recollections

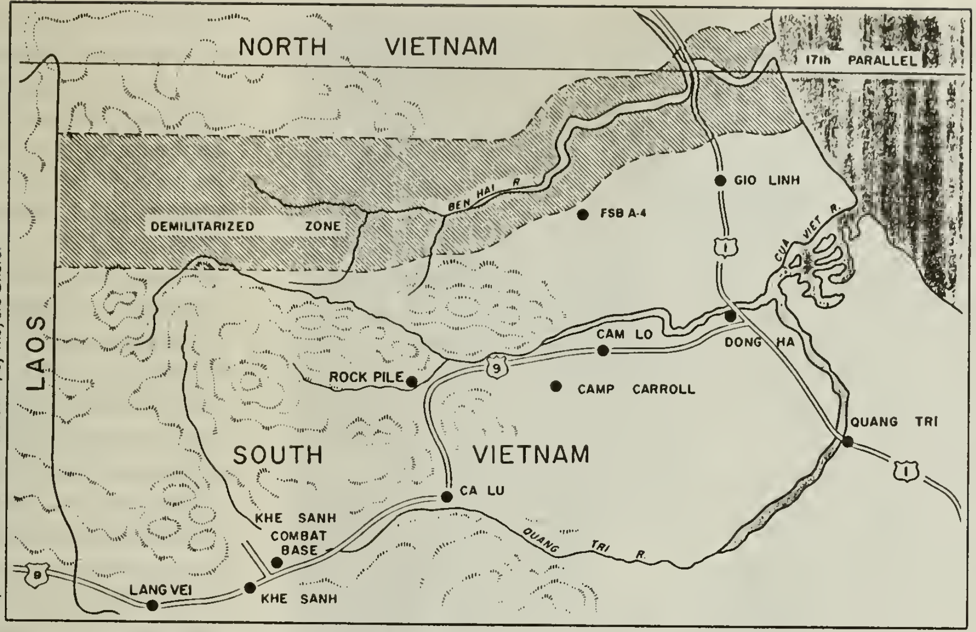
By Command Sergeant Major (Ret.) Steven J. Rogge

In January 1990, the Association of the United States Army (AUSA) magazine, *ARMY*, published an article called "The Road to Laos," by Robert P. Miller. Miller was an engineer lieutenant in the 14th Engineer Battalion in 1970-71. The article was his account of a large-scale operation known as "Dewey Canyon II" (for the Americans) or "Lam Son 719" (for the South Vietnamese Army). Many books and articles have been published about Dewey Canyon II, so I won't rehash that. One of the best books, *Into Laos: The Story of Dewey Canyon II/Lam Son 719,* by William Keith Nolan, is in most libraries.

I was a combat engineer squad leader in B Company, 14th Engineer Battalion, and have vivid memories of the experiences Miller described. What follows are my recollections and interpretations of the operation plus some advice for young combat engineers in today's Army. Many squad members of the 14th Engineer Battalion will probably recognize themselves in this story.

Background

The 14th Engineer Battalion was headquartered at Quang Tri, near the border of North Vietnam. Most of the companies were working the area's road network and improving fire bases for the 1st Brigade, 5th Mechanized Division, and the Special Forces camps that necklaced the border. Charlie



Map from *The Battle of Khe Sahn*, by Moyers Shore.

Northern Quang Tri Province

Company was just south of Quang Tri, at Fire Base Nancy, working with the 101st Airborne Division.

As I understood the mission, this was to be primarily an Army of South Vietnam (ARVN) venture with American advice and support. The ARVNs were to establish control of the northwest border area of North Vietnam and Laos. If all went as planned, ARVN ownership of this area would stop the North Vietnamese Army (NVA) from sending war supplies down the Ho Chi Minh Trail and other routes to the Vietcong and regular NVA forces. There would also be a neat psychological benefit of controlling Khe Sanh again and wiping the slate clean on that disaster.

Preparation

In December 1970, there were indications that something big was coming up. Quang Tri became the scene of incredible culvert assembly activity, M4T6 H-frame construction, and other prefab operations. Of course, with all the extra work, rumors abounded. Almost everyone believed the United States was going to invade North Vietnam with a major push across the Ben Hai River at Fire Support Base Alpha 4 (FSB A-4 on map). In Bravo Company, we had spent November and part of December doing major bridge construction on QL-1, which led into Quang Tri. We also worked on the road network out of Cam Lo toward the river border to the north. Work on Highway QL-9 toward Fire Base Vandergrift, Khe Sanh, and Laos didn't extend far past Fire Base Carroll and the shadow of that infamous rock pile.

I remember well when the S3 and the company commander called us squad leaders together in late January 1971 to review aerial reconnaissance photos of several culvert/bridge sites. We were told that we might soon have a mission using prefab materials. We were to become familiar with a particular site because there would be no on-ground reconnaissance before the mission. The photos had no grid coordinates, so we couldn't do any terrain association or other planning.

Assignment

As a squad leader, I didn't attend any intelligence briefings or planning sessions. I was only told that we would move out in a few days and to prepare for a bridge/culvert mission. We were not to plan on coming back for weeks or maybe even months.

I checked the demo box real well and replaced all the blasting caps and C4 with new stuff. At this point, I had been in Vietnam for almost two years and was pretty good at guessing. When I could go to supply and change demo and ammo with no questions asked, and get new magazines and some blasting machines—well, that told me it was a big operation. However, I still thought we were going to North Vietnam. New poncho liners, new rain gear, and C-rations were handed out like we were "somebody." We loaded our rucks on the back of the squad's 5-ton dump truck and got in line. The driver scrounged some 5-gallon cans and filled them with diesel in case we got separated from the company fuel truck.

The line moved very slowly. Everybody was heading out of Dong Ha, past Cam Lo, for Fire Base Vandergrift. When we got there, it was either full or the battalion commander didn't want to

Illustration by SP4 John P. Vanderhoef, 1967

mess with the traffic and congestion. Or maybe, right from the beginning, Bravo Company wasn't going there. Anyway, we went down the road a few more clicks to a bend and stopped beside a fence. Somebody from battalion S2 told us this was our staging site and it was in the middle of an old minefield. He gave the company commander a minefield report form that had been filled out by the French in the 1950s. (Of course, it was in French!)

We started to clear the minefield by the book, but the ground was incredibly overgrown and mine detectors just weren't feasible. A few guys got some shrapnel from an antipersonnel mine but were not evacuated. Finally, someone determined the area should have only antipersonnel mines, not antitank. A couple of D7 dozers were unloaded and started scrapping the brush, weeds, and small trees to make a clearing about 400 meters in diameter. There were some small explosions—just enough to cause some excitement after the long, slow ride.

Engineer Corner

We moved in, established security, and started to put up triple standard concertina wire. Right across the road, there was a 30- to 40-foot bluff where battalion headquarters, or at least the battalion S3, moved in and established a small helipad. It soon became known as "Engineer Corner." I don't know who named it, but we all liked the name and in future days Engineer Corner acted as a good reference point.

Most of the 5-ton dump trucks pulled pole trailers loaded with three or four 20- to 24-foot tubes of 36-inch culvert. These were already prepared with slings for future helicopter delivery. We did final checks and then crawled into the culverts to sleep. Just before midnight, the squad leaders were given prepare-to-move orders. The truck drivers and the equipment on the trucks remained in place. The squad leaders and the rest of the squad checked out and activated mine detectors. We were lined up at the exit of Engineer Corner and given a bad aerial photo of our culvert/bridge mission site. The photo was no help at all.

We moved down route QL-9 toward Khe Sanh. The night was unbelievably dark, and all the teams stayed bunched up tight. The road hadn't been used for months and was extremely overgrown; no one knew if it was mined or not. Teams of engineer mine detector operators led the way and alternated, but we had no confidence in this method of advancement. We moved slowly because of overgrown brush, darkness, and unfamiliar territory. Except for a bulldozer and an APC or two up front, we were all on foot.

The whole scene was eerie. The blackout lights on the dozer and APC cast weird shadows, and it looked like we were moving down an endless, round tunnel about 10 feet in diameter. That was the extent of our world and there was some griping and bellyaching. Everybody had an idea about what they would do if they were in charge. Finally, vehicle lights were turned on, and we were happy. When my mine detection team was up for a turn, I overheard the leaders discussing the slow progress and deciding not to use mine detectors. The comment, "Let's thunder this mother," was greeted with approval from all. That was a wise decision made on the spot by aggressive leaders. Our speed picked up a little then, but the dozer still made a few wrong turns and had to backtrack and restart.

Mission

The mission of the 14th was to open the road to Khe Sanh. As we moved down the road, engineer squads dropped off at problem areas and were tasked to fix the problem for continuous convoy traffic. I can't remember which culvert/bridge site number was assigned to my squad, but we eventually got there and were left alone in the night while the rest of the party continued on. Soon, even their noise stopped. Because squads were shorthanded, there was only four of us. We set up security and waited for dawn. Having studied the photos, I expected the only site preparation needed would be a little dozer work, and a dozer and an operator were also part of my team. At first light, I was to inspect the blown-out bridge to see if the abutments were strong enough for an AVLB or an M4T6 dry span. If not, I was to choose a culvert site.

It was the rainy season, and our bridge was now a ravine with steep banks and rushing water. Inspection revealed the bridge abutments would not support an M4T6. The abutments, about 30 feet high, had crumbling concrete and timbers that could not be repaired using field-expedient methods. There were no good culvert sites but I had to put a culvert system in someplace. About 0600, the dozer started a bypass. By the time the dozer operator had worked his way down to the bottom of the ravine, he hit some soft ground and ended up sunk over the tracks. I immediately called for a backup dozer. About this time, the skies were filled with flying cranes and other choppers carrying sling loads of culvert tubes and M4T6 H-frame assemblies. I had already reported the condition of the abutments, so a load of culvert was on the way. The chopper operator called to pop purple; we did and got our culverts.

We chose another site about 5 meters from the buried dozer and had to manhandle the culvert into position. We placed two 36-inch tubes on the bottom and one on top in a pyramid shape. There was one extra tube of culvert in case it was needed. The dozer operator cut fill from the banks and approaches to cover the culverts. He did great work in a short time, and our bypass was soon ready. A few vehicles were already waiting to continue on toward Khe Sanh, and we let them go through.

Our squad was responsible for the road a few clicks in each direction from our site. We were to keep traffic moving, improve and widen the road (with only a dozer), and regulate traffic across the bypass. Initially, the traffic pattern concept allowed vehicles to go both ways, but in many places the road wasn't wide enough for that to happen. On more occasions than I care to remember, a truck going one way would meet a truck going in the opposite direction. There they would sit, front bumper to front bumper. They both had the most important mission in the world and would not back up or allow the other to pass. With the heavy traffic, it only took a few minutes for hundreds of vehicles to be stopped and unable to progress. I especially hated it when that happened on my section of road.

The dozer operator, however, was always willing to help. He would approach one of the trucks (after I had warned them) and, with a verbal warning to the Americans or a sign language warning to the ARVN, start to nudge them toward the edge of the bank and off the road. That would usually clear the mess, but it wouldn't be long before two other hardheads would be in the same situation. As I recall, an MP finally came up with a solution: have the road open for 11 hours going one direction only, then an hour of maintenance for the engineers, then 11 hours going the other direction. This commonsense solution really worked. Vital supplies were able to get through, and equally vital empty trucks became available for future loads.

Disabled vehicles that completely blocked traffic were simply dozed over the edge. Luckily for us, one of the first vehicles to go over the edge in my area was loaded with about eight pallets of C-rations. We took a few cases of the C-rations and never worried about food resupply. The trucks that went over loaded with ammo, though, made us nervous. We didn't have the men or the time to continually guard them and no other security was available. Our fear was that the NVA would light up the night with a trailer load of 8-inch rounds.

Just after we got the tubes of culvert, a chaplain showed up and wanted to conduct services. I told him I was pressed for time; he said it wouldn't take long to pray for us, so I let him set up. He kept his word and talked for a few minutes. We prayed, felt better, and then he left. I don't know his name or unit; he just showed up. Maybe that's why the second culvert site was better, we got it in faster, and traffic moved sooner than I thought possible.

We knew from the amount of ground and air traffic that this operation was incredibly huge, and we felt good that we were part of it. The squad and I took pride in our little section of road and did our best to improve and maintain it. After a couple of days, I received a tasking to provide two squad members for other missions. They worked the whole area—from laying matting and runway repair at Khe Sanh with the 27th Engineer Battalion to helping rebuild a Bailey bridge.

Bailey Bridge Rebuilding

The Bailey bridge incident should never have happened but did. The Bailey bridge was installed near Fire Base Vandergrift. It had a high load classification but was not safe for an M88 tank retriever towing an M60A1 tank. I think Alpha Company, 14th Engineers, was responsible for that bridge; they had built a suitable bypass for big loads. When an M88 towing an M60A1 approached and wanted to cross, the bridge guard told them to use the bypass. For whatever reason, the M88 crew started across the Bailey anyway. They almost reached the other side before it collapsed. Of course, that required all traffic to use the bypass, which was restrictive and took longer to negotiate. Additional Bailey bridge material was brought up, and A Company, 14th Engineer Battalion, (with some fillers) installed another bridge. That mission would not have been needed if the M88 crew had listened to the engineer bridge guard.

Well, I've rattled on and on, but we all have some favorite war stories. This operation was exciting for me and provided immense satisfaction because engineer soldiers contributed significantly to the success of a large operation.

Lessons Learned

As I look back at the Vietnam War and my actions in that war, I can see that my single, most important accomplishment was the ability to successfully complete independent operations and missions as a combat engineer squad leader. The companies and battalions to which I was assigned were never without an abundance of missions. Consequently, engineer squads were often attached to many different units and had a wide variety of missions. Senior leaders could not be at every site all the time. They provided training and guidance, but eventually we squad leaders headed for the jungles pretty much on our own. We were tasked out and worked directly for artillery or infantry units. We were automatically afforded the respect of being the engineer "experts."

Today, combat engineer squad leaders often lead and prepare the way for maneuver elements and task forces going to war. Army training programs, therefore, must allow squad leaders to develop the skills and confidence they will need to make sound engineering decisions quickly in the heat of battle. A training program that encourages independent actions, coupled with training in a cohesive engineer unit environment, produces the best qualified squad leaders. This training should not focus entirely on the squad leader but include how the squad will function in the absence of the leader.

Today, the training for our engineer squads must encompass more than just battle drills and task-oriented scenarios. Senior NCOs and officer leaders must emphasize the value systems of our Army and our nation. Soldiers who embrace, without qualification, their oath to defend our Constitution will be those who emerge as the next generation of successful leaders. In my opinion, what an engineer squad does or fails to do on the battlefield has more impact on the outcome of that battle or hostile situation than virtually any other similar-sized element of the U.S. Army.

If I was a young squad leader starting out today, I would ensure that I was an expert in much more than the "normal" engineer tasks. Taking care of a squad means knowing the leadership skills of forging that squad into a team and accomplishing the mission despite any adversity or hardship. I would also do whatever I could to minimize self-inflicted wounds that needlessly become a hardship. I would know—

- How to thoroughly maintain my vehicle and communications gear.
- How to use the supply system so my squad had what it needed and had it on time.
- More about living and working in field situations than the average person really cares about.
- My chemical detection equipment and procedures inside and out.

I could go on, but the main concept is that I would never be satisfied with meeting a minimum requirement. Successful soldiers and leaders train to proficiency. A positive attitude and an in-place values system are the prescription for a healthy combat engineer squad.

Command Sergeant Major (Ret.) Rogge is the business manager of the Army Engineer Association at Fort Leonard Wood. He retired from the U.S. Army in 1989 after serving 22 years on active duty and 4 years with the Minnesota Army National Guard (ARNG). His assignments included tours in Vietnam; Germany; Fort Lewis, Washington; and three tours at Fort Leonard Wood, Missouri. He also served as an advisor for the Minnesota ARNG and as a recruiter in Peoria, Illinois, and South Bend, Indiana.

ENGINEER UPDATE

Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

Environment Branch. A new Environment Branch in the Engineer School is responsible for developing and exporting environmental awareness training support packages to all proponent schools within TRADOC. This initiative is in response to TRADOC direction that all schools integrate environmental awareness training into their programs of instruction by 31 March 1994. Initial packages were distributed in January and additional material is being developed. POC is Major David Neeley, -4122.

51T Advanced Individual Training (AIT) Course. The first 51T AIT course will begin on 4 April 1994 at Brown Hall, Fort Leonard Wood. This course signifies the consolidation of the 82B (construction surveyor), 81B (technical drafting specialist), and 51G (materials quality specialist) MOS into the 51T MOS (technical engineer specialist) at the 10 level. The 19-week course incorporates the latest drafting and survey automated technology in the construction industry; it is not a consolidation of the old courses. Soldiers graduating from 51T AIT will arrive at their units well versed in the newest construction systems fielded. POC is CPT Andrew Goetz, - 4114 or (314) 596-0997.

62F, Crane Specialist, AIT Training. Class No. 508, 31 May-19 July 1994, will be the last to provide 62F soldiers with training on the 12-1/2T crawler and the 20T rough terrain crane at Fort Leonard Wood. This action is in response to Department of Army direction to turn in the 12-1/2T crawler and two models of the 20T rough terrain crane. Additionally, no monies will be spent to purchase repair parts or do GS/depot maintenance. After 1 June, all critical crane tasks except dragline will be taught on the hydraulic crane. Operators trained on hydraulic cranes easily adapt to performing the same tasks on mechanical cranes after they learn the controls. Three tasks in the 62F soldier's manual now trained at AIT will be trained at units:

- Install Dragline
- Excavate an Area with the Dragline Bucket
- Dredge Material from an Area with the Dragline Bucket

POC is CPT Steven Passey, -4112.

Directorate of Combat Developments (DCD)

M9 ACE Scarifier. Lessons learned from the Combat Training Centers reveals two major causes of blade damage when opertors use the scarifier. First, damage results when operators use the scarifier in soil conditions that exceed the intended purpose of the equipment. *M9 ACE News 'N' Views*, August 93, states, "The intent of the teeth is to assist in cutting through hard, rocky soil, NOT to dig through nearly solid rock." Second, damage occurs when the M9 ACE travels cross-country with the blade unfolded. The solution is to fold the blade in accordance with TM 5-2350-262-10. Failure to follow these instructions can cause serious injury to the operator or damage to the equipment. POC is SFC Tommy Simmons, -4085.

Forklift Attachment for MW24C 2-1/2 CY Loader. A quick-release forklift attachment may soon be approved for the Case MW24C 2-1/2 CY Loader. Testing on the forklift assembly package began in September 1993 and will conclude in May 1994. The Engineer School is evaluating the 10,000-lb forklift attachment, a quick-disconnect plate, and necessary modifications to the existing bucket. The three-piece assembly may be available for purchase through the Federal Supply System as early as May.

The forklift attachment assembly will be packaged as a complete kit with all required hardware and will cost about $6000. The initial installation process requires 32 to 40 man-hours. Once installed, the quick disconnect system provides a fast and safe means of attaching and detaching the forklift assembly or the 2-1/2 CY bucket without leaving the cab of the loader. POC is CW4 Melad Smith, -4074.

Forklift attachment (view 1)

Forklift attachment (view 2)

Robotic-Technology Insertion Activity (R-TIA). MG Ballard's initiative to bring engineers to the forefront of robotic systems development has resulted in the establishment of a Robotics-Technology Insertion Activity (R-TIA) at the Engineer School. The intent is to put prototype robotic systems in soldiers' hands for their evaluation and input to the development process. In FY 94, engineers at Fort Leonard Wood will have the opportunity to evaluate an unmanned Combat Engineer Vehicle; an unmanned miniflail for breaching antipersonnel minefields; the Canadian JINGOSS, which is a mine-detection system for route clearing; CROSSBOW, which is a remote-controlled side attack, antivehicle/antitank land mine; and a prototype unmanned engineer armored vehicle. An unmanned HMMWV and unmanned 5-ton truck may also be evaluated in FY 94. POC is Dr. Robert Sickler, -4079.

Engineer Branch Safety Office (EBSO)

User Warning for Luxfer Air Cylinders. All Luxfer 4500 psi hoop-wrapped SCBA air cylinders manufactured before May 1985 have the potential to rupture, causing serious injury or death. Recall notices have been issued but about 15 percent of the units remain in the field. A protective steel neck ring that will eliminate the hazard can be retrofitted to the cylinder. For more information, call LUXFER at (909) 684-5110 or Buddy Dennard, Dobbins AFB, DSN 468-2736. POC is Mark Totzke, -4080.

News and Notes

249th Engineer Battalion Award. The 249th Engineer Combat Battalion (Heavy) has been awarded the Meritorious Unit Commendation for the period 8 December 1990 to 27 April 1991. This award was based on the battalion's actions during Desert Shield/Storm.

Although the battalion was inactivated in October 1991, individuals assigned to the unit during the award period are authorized to have the award annotated to their military personnel records. Additionally, individuals are authorized to wear the award (ribbon) as personal awards on the uniform. For information and documentation, call LTC Philip Federle at (703)614-5863 or DSN 224-5863.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

> *"Our forces can be deployed from anywhere in the world. To maintain this capability requires great leadership by our soldiers and a great NCO Corps. To succeed in this profession you must love being a soldier and love being a leader. You must believe in your country and your Army, be in the best physical and mental condition, and be technically and tactically proficient. If not, find a new profession."*
>
> *SMA Richard A. Kidd*
> *Sergeant Major of the Army*

This quote from the Sergeant Major of the Army is inspiring and sets the standard for all soldiers, especially Non-Commissioned Officers (NCOs). Without doubt, NCOs love being soldiers and leaders and believe in their country and their Army. Other tenets of this quotation need special attention and are the subject of this article.

NCOs must become technically proficient so they can successfully perform all tasks and functions related to their position, including the ability to operate and maintain all assigned equipment. The Self-Development Test (SDT) plays a vital role in measuring proficiency in technical and leadership skills. NCOs should use this tool to monitor and set goals for their own technical proficiency. But self-development does not stop with the SDT. It is the NCO's responsibility to seek out college courses and the recommended CMF-related courses and activities located on the Career Development Model to improve his or her leadership skills.

NCOs must develop technically and tactically trained soldiers who have discipline, are physically strong, mentally tough, and highly motivated. NCOs must train their soldiers on every task critical to wartime mission accomplishment so those soldiers will be confident of their ability to perform well under the difficult and demanding conditions of battle. Effective training is the key to sustaining the mobility, deployability, and lethality of today's combat-ready Army. Technically and tactically proficient NCOs are the key to (and result of) effective training.

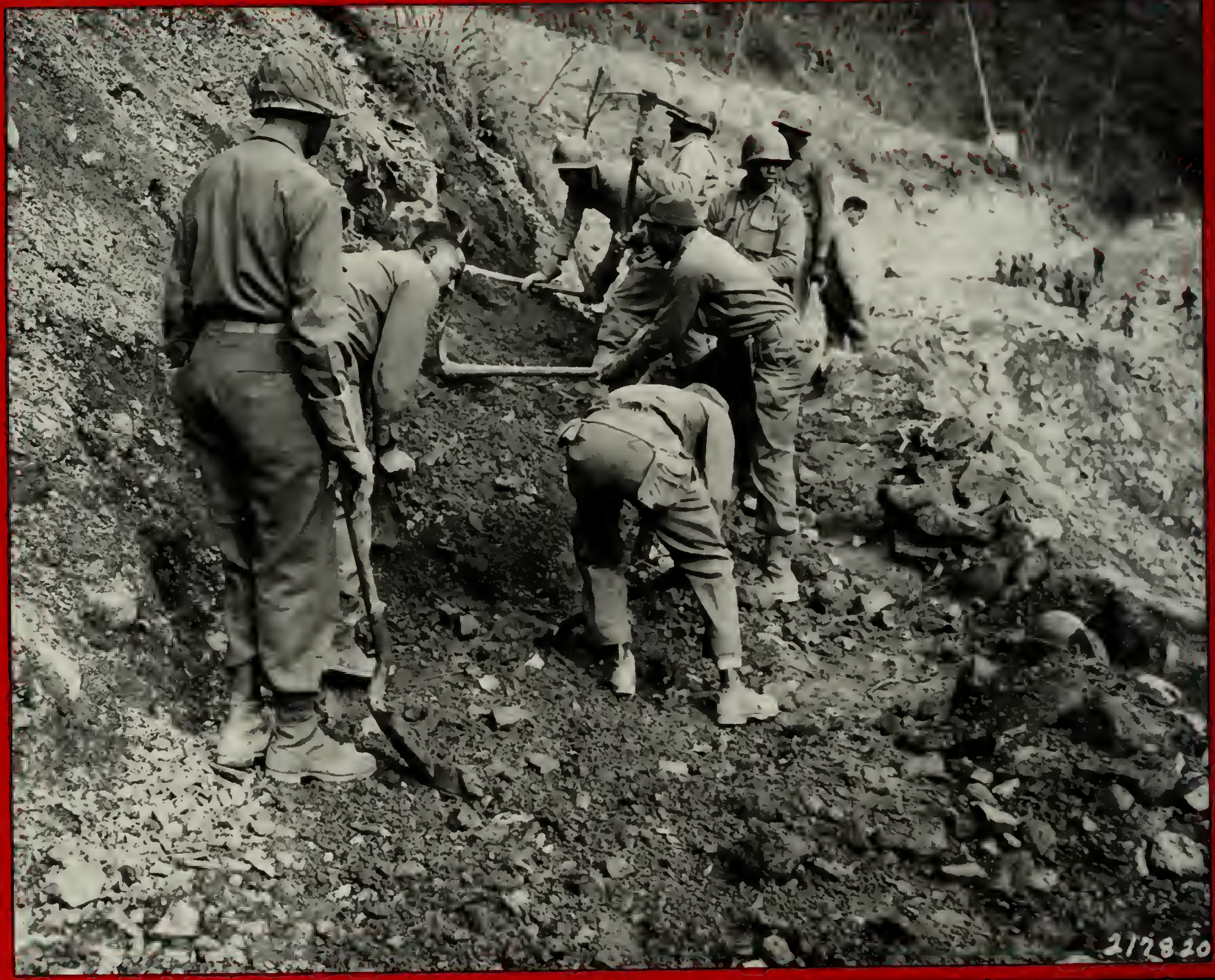
To develop effective training, NCOs must know and use the nine principles outlined in FM 25-101, *Battle Focused Training.* Three of those principles are discussed here because they are at the heart of what a successful NCO is all about.

Performance-Oriented Training. Soldiers train better, faster, and to a higher degree of proficiency when they know the task, conditions, and standards. Training becomes more effective when soldiers must perform to a standard rather than simply complete a procedure within a time frame dictated by a training schedule. Enforcing performance standards helps NCOs identify and correct training deficiencies and provides an accurate assessment of combat capabilities.

Train to Challenge. NCOs must provide training that is tough, realistic, mentally and physically challenging, and that excites and motivates their soldiers. Challenging training builds competence and confidence by developing new skills. It instills loyalty and dedication and inspires excellence by fostering initiative and enthusiasm. Challenging training builds aggressive, capable soldiers.

Train to Sustain Proficiency. NCOs must ensure that once soldiers have trained to standard, they maintain proficiency through sustainment and opportunity training. Sustainment training reinforces skills and tasks already mastered by the soldiers. Opportunity training is the conduct of preselected, preplanned critical tasks that require little explanation. It is conducted when proficiency has been reached on a primary task and time is available. For example, a combat engineer squad leader may conduct opportunity training on the identification of threat mines while waiting for his squad to participate in a manual breach of a minefield. NCO leaders should prepare for opportunity training by preselecting critical tasks that fit the above described criteria before every scheduled training event.

In summary, NCOs must establish themselves as experts in training and team building. NCO leaders must ensure their soldiers can cope with the complex, stressful, and lethal situations they will encounter on the next battlefield. They must train technically and tactically proficient soldiers who are mentally and physically strong and who are ready for deployment from anywhere in the world. In addition, NCOs must pass on the legacy that in this profession you must love being a soldier, love being a leader, believe in your country and in your Army, or find a new profession.



Members of the 2nd Battalion, 370th Regimental Combat Team, 92nd Infantry Division, build a by-pass on a road blown out by Germans in Cutigliano, Italy, October 1944. The 92nd Division was one of two predominantly African-American divisions in World War II. U.S. Army Signal Corps photo.

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The Great Flood of '93

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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

In June 1993, with the publishing of FM 100-5, the U.S. Army officially recognized versatility as the fifth basic tenet of Army operations. Versatility has long been one of the basic principles and proud traditions of our Engineer Regiment. But in today's uncertain strategic environment, where resources are dwindling and Army missions are increasing, our regiment must remain versatile to meet the challenges we will face.

This month the U.S. Army Engineer Center is hosting the sixth annual Senior Engineer Leaders Training Conference (SELTC) at Fort Leonard Wood. I have selected "versatility" as the theme of this year's conference because of the many diverse missions engineers have been called to perform since the end of the cold war. Numerous engineer units have distinguished themselves and have demonstrated their versatility by successfully accomplishing a wide range of missions either sequentially or simultaneously.

The recent operation in Somalia is just one example that shows our regiment's versatility. Often on the same day, engineers found themselves supporting humanitarian operations, then combat operations, and then back to humanitarian operations. Before they deployed to the horn of Africa, those same engineers were in Dade County, Florida, providing assistance to the victims of Hurricane Andrew. Those versatile engineers excelled in a wide variety of rapidly changing missions.

Versatility is reflected in the way our regiment adapts to different missions and tasks, many of which are not on unit mission essential task lists. Our regiment has always prided itself in meeting the challenge of rapidly and efficiently shifting focus, tailoring forces, and moving from one mission to another. But today's force-projection Army demands an even more versatile Engineer Regiment.

We are now faced with a dynamic global environment, where assumptions made during the cold war no longer apply. Forward defense has given way to force projection, and AirLand Battle doctrine has evolved to the doctrine of Full Dimensional Operations. Versatility is essential for a force projection Army, where engineer units must rapidly build and sustain substantial combat power in remote parts of the globe and achieve success in a wide range of missions.

Engineer soldiers must seek ways to perform a wide range of roles, in a wide range of environments, and under the conditions of war and operations other than war. Full Dimensional Operations in the 21st century will require our regiment to expand its already wide variety of basic competencies and skills. Our officers and noncommissioned officers must be mentally agile and competent across the entire spectrum of engineer functions in both war and operations other than war. Our units must be multifunctional; operate at tactical, operational, and strategic levels; harness new and evolving technologies; and deploy as modular and tailorable elements. As in the past, our regiment needs soldiers who are well led, well trained, well equipped, and held to high standards. This is, and will continue to be, a truly challenging and rewarding time to be an engineer soldier.

Articles in this issue of *Engineer* highlight our regiment's versatility. Lieutenant General Williams addresses the Corps of Engineers' 1993 flood assessment and future flood control proposals. Lieutenant Colonel Davis and Major Feierstein discuss the 43rd Engineer Combat Battalion's deployment to construct Victory Base in Somalia. And, Mr. Stewart addresses engineer support to the theater in force-projection operations. These and other articles portray a versatile Engineer Regiment, one that is capable of operating across the full spectrum of military operations.

Versatility is of great interest to the leaders of our Army and our regiment, and is a timely theme for the SELTC. This year's conference features presentations that promote that theme. Speakers include the Chief of Engineers, the Commander of the XVIIIth Airborne Corps, the Commanding General of the U.S. Army Combined Arms Command, the Director of the Army staff, the Deputy Commander and Chief of USAREUR, the Commander of the 10th Mountain Division, the Director of the Louisiana Maneuvers Task Force, and the Commander of Joint Task Force Six. As always, the conference provides an opportunity for the military engineering community to focus efforts and resolve key issues. The goal is to share experiences and gain the knowledge needed to develop a better trained and more versatile Engineer Regiment.

While the SELTC presents information and challenges for our senior leaders, we must remember that the versatility of the regiment begins in the mind of the engineer soldier. The imagination and ingenuity of our engineer soldiers will help us maintain and carry forth our proud tradition. ESSAYONS!

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Cover photo: *A rural home owner taunts Mother Nature as floodwaters creep towards his front door. U.S. Army photo.*

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The Corps' Response to the Great Flood of 1993

By Lieutenant General Arthur E. Williams

This article is an edited version of LTG Williams' statement before the Subcommittee on Investigations and Oversight, House Committee on Public Works and Transportation, October 28, 1993.

Flooding in 1993 of the Upper Mississippi and Lower Missouri River Basins was the most devastating flood in our nation's history. Nine states: North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, Illinois, Kansas, and Missouri, received the brunt of nature's onslaught.

The great flood of 1993 was a rare event, which many hope will not be repeated in their lives. Expected to occur only once every 100 to 125 years (which equates to a 0.8 percent to 1.0 percent chance of occurrence), the flow of water down the Mississippi River to St. Louis peaked at 1.1 million cubic feet per second. At locations in the upper Mississippi River, flooding approached a 500-year flood. Pappillion, Nebraska, received an inch of rain in only six minutes; at Fargo, North Dakota, the Red River rose four feet in just six hours. Uncommon events such as these quickly became commonplace throughout the midwest.

This flood event left an unforgettable mark on the people and the land. Not only was the flood characterized by its record peak levels, but also by its sheer volume and duration. The volume of runoff produced by incessant and protracted rains dwarfed that produced by the previous record flood of 1844. At St. Louis, the Mississippi River remained above flood stage for more than three months.

This article describes the Corps of Engineer's role in this epic flood, summarizes the damages and relief efforts, and identifies lessons learned during the recovery process.

The Corps Role in the Region

The U.S. Army Corps of Engineers constructed and operates a vast flood-control infrastructure on tributary rivers in the Upper Mississippi

River Basin. This system consists of 72 dam and reservoir projects, more than 200 levees, floodwalls, pumping plants and diversion structures. Additionally, other federal agencies and numerous nonfederal public and private interests have built thousands of flood control structures throughout the basin. Some of these flood control structures are eligible for Corps assistance during flood disasters.

Each reservoir in the system has a water control plan that specifies how water will be stored and released under a variety of hydrologic conditions in its watershed. Under flood conditions, reservoirs impound and later release floodwaters in a controlled manner to lessen the impact downstream. By August 1, 1993, reservoirs in the midwest were at their peak storage—almost 20 million acre-feet of floodwater. Once a flood crest has passed, operating plans call for the release of stored floodwaters as quickly as possible without further impacts to the flooding downstream. It is important to rapidly return each reservoir to its normal pool level so storage space is available to capture the next flood. The Corps operations in the spring of 1993 were no different in this regard.

Federal navigation projects in the Upper Mississippi River Basin are vitally important to our nation's economy. Upstream from St. Louis, there are 34 locks at 29 sites along 854 navigable miles of the Mississippi River. Along the 753 miles of navigation on the Missouri River, there are no locks. The Illinois River has nine locks along its 327-mile system, and the Kaskaskia River has one lock on its 30-mile length. Navigation on these flood-swollen rivers was essentially stopped from June through August 1993 because of dangerous channel conditions. Navigation industry losses exceeded $300 million. As an example of the impact on navigation, approximately 8 million tons of cargo normally pass through Lock 27 near St. Louis during the month of July. The total tonnage for July 1993 was zero. Other locks within the system above St. Louis reported similar impacts.

Damages

The great flood of 1993 earned the dubious distinction as the flood of record. Unlike a hurricane or earthquake, where the disaster strikes quickly, the 1993 flood sustained its relentless attack from the spring through the summer, leaving 50 people dead in its wake. It inflicted more than $20 billion in damages. Communities witnessed the destruction and damage to 72,000 homes. Water inundated 20 million acres of agricultural land, destroying $1.5 billion of soybeans in Illinois and $1.0 billion of corn in Iowa.

The Corps' flood control infrastructure, including flood control reservoirs, levees, walls, and other structures, performed extremely well during the crisis; they prevented billions of dollars in damages. For example, of the 230 levees constructed by the federal government, only 38 were overtopped and two breached, compared with an 80 percent rate of overtopping and breaching of private levees. Since the flood, the Corps has begun spending an estimated $250 million to make repairs to both federal and nonfederal levees.

Photo this page: **At Sny Island, Illinois, a dozer clears dredged material from the riverbank.**

Photo opposite page: **A railroad bridge at Glasgow, Missouri, succumbs to rising water. Floodwaters ravaged the midwest from spring through late summer 1993.**

Flood waters moved large quantities of sediment into the navigation channels, causing additional damage. Estimates are that $11 million worth of dredging will be needed to restore these navigation channels.

Recreation areas were also affected. The Corps temporarily closed more than 100 recreation areas, either fully or partially. Shower buildings and comfort stations were severely damaged, roads and areas around boat ramps and swimming beaches were eroded, and campsites were destroyed. These recreation areas suffered damages amounting to about $11 million.

Relief Efforts

The Corps operates under two basic emergency authorities that allow it to prepare for and respond to disasters. These authorities are the Flood Control and Coastal Emergency Act (Public Law 84-99, as amended) and the Robert T. Stafford Disaster and Emergency Assistance Act (Public Law 93-288, as amended). Public Law 84-99 permits the Chief of Engineers to undertake activities that include flood response and rehabilitation of flood control works. Under the Stafford Act, the Federal Emergency Management Agency (FEMA) developed a contingency plan for a holistic federal response called the Federal Response Plan. This plan calls on 26 federal departments and agencies and the American Red Cross to execute coordinated disaster relief and recovery operations. Specifically, it allows FEMA to assign public works and engineering missions to the Corps. The intent of both the Stafford Act and Public Law 84-99 is for the federal government to assist states, not to take over and direct disaster relief operations.

Under the authority of Public Law 84-99, the Corps assists state and local agencies with planning, flood fighting, and the rehabilitation of eligible flood control structures. The Corps maintains supplies such as sand bags and pumps for use in flood fights. If these stocks are depleted, each district emergency operation center has on file lists of sources where supplies and equipment can be quickly procured. As early as June 1993 the Corps began to distribute what would eventually exceed 31 million sand bags and loaned 430 pumps to aid local communities. In some instances the Corps contracted with private construction firms to reinforce levees. This emergency work amounted to about $25 million. Our professional engineers also assisted local governments by providing technical advice. By working closely with the levee districts, local and state officials, and other federal agencies, the Corps maximized its effectiveness during the response phase.

Once FEMA activated the Federal Response Plan on July 11, 1993, the Corps executed FEMA-directed missions. The Environmental Protection Agency, U.S. Public Health Service, Departments of Transportation, Agriculture, and Interior, and the General Services Administration provided valuable support to the Corps mission assignments. The Corps provided damage surveys, generators, and portable toilets; installed culverts; and supplied potable water. A significant water supply mission involved the transportation and storage of potable water to Des Moines, Iowa, when that city's water treatment plant was flooded. The recovery phase of the mission included technical assistance to rehabilitate the plant and restore the water supply to approximately 250,000 people. The cost of these FEMA missions amounted to more than $20 million.

Throughout this flood emergency, the Corps coordinated relief operations with several federal agencies—the U.S. Coast Guard (USCG), the U.S. Geological Survey (USGS), the Bureau of Reclamation (BOR), the National Weather Service (NWS), the Soil Conservation Service (SCS), and the Federal Emergency Management Agency (FEMA). Of particular note, the Corps called on the USGS to make additional flow measurements at key river locations for use in making water control decisions. Because of the close working relationship between the Corps and USCG, navigation issues and safety concerns were quickly addressed and disseminated to the public. Engineers from the BOR supplemented Corps damage survey teams so that damages were rapidly quantified. A triumvirate of the Corps, SCS, and FEMA coordinated federal policies regarding levee rehabilitation and developed joint management teams at the disaster field offices established by FEMA. In late August, representatives from the U.S. Fish and Wildlife Service (USFWLS) and the Environmental Protection Agency (EPA) were added to these interagency teams to evaluate nonstructural alternatives to levee repairs where appropriate. Contractors, soldiers and private citizens emerged to lend their valued support. All partners contributed their personnel, expertise, and professionalism. This team effort expedited relief operations and alleviated the suffering of those affected.

Especially productive were the efforts to bring back navigation to the Upper Mississippi River Basin without creating additional damages to, or threatening the stability of, weakened levees. The possibility that the wakes caused by barge traffic would further damage levees alarmed local officials. On July 19, the Corps met with the River Industry Executive Task Force and the Coast Guard to develop a plan for restoring navigation. The plan included a test tow protocol for opening the waterways. The plan of operation included a navigation traffic control center for direction, monitoring, information exchange, and public announcements. The test tow protocol required that three tows descend the Illinois and Mississippi Rivers to determine if wave action would cause additional stress to the levees. Levee district representatives rode the three tows to see first-hand the effects of commercial traffic. We commend the navigation industry for this cooperative effort. The River Industry Executive Task Force exemplifies what government and industry can accomplish in cooperative approaches to problem solving.

Volunteers fill sandbags at Roshenport, Missouri. The Corps provided more than 31 million sandbags to the midwest to hold back flood waters.

The flood fight demanded a massive commitment of Corps personnel. When the call went out for assistance, more than 1,000 Corps team members came forward and volunteered for duty in the affected areas. They deployed to the three Corps divisions (North Central, Missouri River, and Lower Mississippi Valley) and their subordinate districts (St. Paul, Rock Island, Omaha, Kansas City, St. Louis, and Memphis). Our volunteers brought that indomitable credo "The Corps Cares." Armed with their professional skills and concern for their fellow citizens, the volunteers worked tirelessly to help mitigate the damage. Throughout the remainder of 1994, between 200 and 500 deployed personnel will finalize levee rehabilitation. Once again, Corps personnel have proven to be our organization's greatest asset.

As the magnitude of the flood grew, I directed the establishment of a coordinating office to oversee the flood fight. Known as the Deputy Director of Civil Works (Forward), the office activated August 4, 1993 in St. Louis. The Forward Office, headed by MG Albert Genetti, Commander of the Ohio River Division, developed a strategic management plan for implementing recovery operations. It provided a regional setting to ensure Headquarters USACE policies were reviewed, interpreted, and applied uniformly. The office also became a one-stop shopping center from which to coordinate all public affairs and to provide liaison with congressional, state, and local interests. On September 17, having set recovery policies and procedures in place, the office closed.

As the floodwaters finally receded during October and November, the Corps began in earnest to rehabilitate more than 200 damaged federal and eligible nonfederal levees. Districts identified 38 levees where immediate and provisional measures could be provided to reduce the risk of further damage. The Corps expedited initial repairs to those levees, with final repairs to follow in 1994 for the remaining eligible levees. All initial repairs will be completed prior to the spring of 1994, when the annual thaw may again threaten to send floodwaters south to the Gulf of Mexico. The first 38 levees entered the Corps' Fast Track Levee Rehabilitation Program. This program typifies the creative solutions the Corps team developed to solve immediate threats to life and property. Design, contracting, and construction teams sped temporary repairs to these levees so that a minimum 20-year level of protection would be in place before the possibility of spring flooding.

Corps contractors will restore many of the more than 200 eligible levees scheduled for final repairs to their predisaster condition; however, more than half of the final repairs will not be completed until late 1994. Thus, the Corps will be fully engaged in rehabilitating levees for more than a year after the great flood of 1993 struck the region.

The Corps' Levee Rehabilitation Program is analogous to an insurance policy that promotes levee integrity and financially protects public levee sponsors. Active program sponsors comply with engineering and maintenance standards that ensure reliable protection against floods. In return, when an eligible levee is damaged by a flood, the Corps funds 80 percent of the repair cost. This program benefits public sponsors and minimizes the destruction caused by floods.

In the aftermath of the 1993 flood, the Corps received more than 500 requests for levee rehabilitation. About 300 of these requests were rejected because levee sponsors had previously elected not to enroll in the Corps program, or because the levees were in an unsatisfactory state of maintenance prior to the flood. These levee sponsors had no Corps "insurance policy." Levee sponsors enrolled in the Corps program spend thousands of dollars each year to maintain the integrity of their levees. Their steadfastness to sound engineering and maintenance resulted in Corps assistance after the 1993 flood—often exceeding $1 million per levee.

Lessons Learned

Some significant lessons learned from the great flood of 1993 follow. The list is incomplete because the task to repair damaged eligible levees will not be finished until late 1994, and we expect more lessons will be learned.

- The Deputy Director of Civil Works (Forward) in St. Louis was a success. Not only was the office able to coordinate implementation of policy, but it was a "one stop" information office that elected officials and members of the public could contact for specific information. The Public Affairs Office released information that affected the entire area to both the news media and the public. Thus, the responsiveness and credibility of the Corps increased with those most affected by impacts of the flood.
- On the engineering front, the Corps recognized the need for a better computer model to simulate the flows of the Mississippi and Missouri Rivers and their tributaries. The computer model will be used to determine impacts of flooding on facilities and water control plans. We are already involved in developing that model and will coordinate with the National Weather Service in its development.
- The automation of data dissemination among the Corps headquarters, divisions, and districts requires improvement to take advantage of current technology. As a result of this flood, we have identified the need to develop a better means for the exchange of water data between federal agencies on a real-time basis.
- The 1993 flood showed that Corps flood control projects, including reservoirs and levees, worked as designed and withstood the test of this flood. The water control plans for the reservoirs helped guide Corps decisions during these unprecedented conditions.
- The emergency operations centers at Corps headquarters, divisions, and districts functioned very well during the crisis. They provided timely responses to needs throughout the affected area.
- The River Industry Executive Task Force worked extremely well and illustrated the benefits of government and industry cooperation.
- The Corps' volunteer program was also a great success. It provided a pool of more than 1,000 individuals who were willing to go to the stricken area and join in the flood fight.
- As a result of the 1993 flood, many sponsors of public levees now realize the value of the Corps' levee rehabilitation program. If more sponsors join our program, more levees will be better maintained and better able to protect life and property.
- Our federal partners are a great force multiplier. Each organization has unique capabilities and dedicated professionals who contributed to the Corps successes. Teamwork provided the most effective relief possible.

The Future

In anticipation of spring flooding during March and April 1994, the Corps has developed an action plan. Routine planning activities include the identification of emergency contractors and borrow sites, and pre-positioning of sand bags and pumps. Additionally, the Corps will continue to educate the public, especially state and local governments, in flood fighting techniques and Corps assistance programs. In cooperation with the National Weather Service, we will assist in forecasting flood-vulnerable areas by estimating rainfall amounts, soil moisture content, and water content of the snow cover. The Corps stands ready against potential spring flooding.

Chaired by the White House, an interagency committee is analyzing floodplain management policies. The goal is to formulate coordinated and coherent interagency policies toward floodplain management that optimizes and balances uses of the floodplains. State and local participation in this effort are crucial. The committee has the difficult, but important, task of balancing the legitimate uses of navigation, flood control, water supply, recreation, industry and economic development, agriculture, environmental preservation, and habitat restoration. It will examine the whole ecosystem, while keeping in mind that 260 million humans are also part of that system. All committee members share a common hope—that the magnitude of the devastation caused by the great flood of 1993 never revisits the midwest. Whatever the decisions resulting from this effort, the Corps will be intimately involved in implementing them.

ESSAYONS!

Lieutenant General Williams is the 48th Chief of Engineers. He previously served as U.S. Army Corps of Engineers Director of Civil Works, Pacific Ocean Division Commander, Lower Mississippi Valley Division Commander, Sacramento District Commander, and 44th Engineer Battalion Commander. He is a graduate of the Naval War College and holds a masters degree in civil engineering from Stanford University. LTG Williams is a registered Professional Engineer in Minnesota.

BIBLIOGRAPHY

Adler, Jerry. "Troubled Waters." *Newsweek*, July 26, 1993, pp. 21-26.

Bryon, Bill. "Riding Out the Worst of Times." *National Geographic*, January 1994, pp. 82-86.

Budiansky, Stephen; Glastris, Paul; and Ferguson, Greg. "Nowhere to Run, Nowhere to Hide." *U.S. News and World Report*, July 26, 1993, pp. 24-28.

"Can't Drown this Town." National Geographic Explorer, WTBS Super Station, Atlanta, GA, January 1994.

Church, George J. "Flood, Sweat and Tears." *Time*, July 26, 1993, pp. 22-33.

Denning, James. "When the Levee Breaks." *Civil Engineering*, January 1994, pp. 38-41.

Elmore, John. Unpublished. "Suggested Remarks for Mr. Elmore at the Midwest Reconstruction and Cleanup Conference." November 18, 1993.

Elmore, John. Unpublished. "Remarks of Mr. John Elmore at the 'Floods, Drought, Ice and River Closure' Panel." 13th New Orleans Maritime Seminar, Tulane University Law School, New Orleans, LA. January 27, 1994.

Elmore, John. Unpublished. "Remarks of Mr. John Elmore to the U.S. Feed Grains Council, 34th Annual Membership Meeting." Scottsdale, AZ. February 8, 1994.

Elmore, John. Unpublished. "Suggested Remarks for Mr. Elmore, Congressional/Executive Science and Engineering Fellows." Washington, D.C., January 11, 1994.

Mairson, Alan. "The Great Flood of '93." *National Geographic*, January 1994, pp. 49-81.

U.S. Department of Defense, Department of the Army, Complete Statement of Lieutenant General Arthur E. Williams, Commander, U.S. Army Corps of Engineers, before the Subcommittee on Investigations and Oversight, House Committee on Public Works and Transportation, October 28, 1993.

U.S. Department of Defense, Department of the Army, U.S. Army Corps of Engineers Strategy and Management Plan for Repair of Flood Control Works Midwest Flooding 1993, August 1993.

Letter to the Editor

Reference Bosnia: Engineer Planning for Operations Other Than War, By Major David R. Brown, *ENGINEER* magazine, November 1993.

The feature article referenced was an interesting introduction to the engineer specific concerns in OOTW. In an arena which includes numerous vital topics, the author succeeds in providing thought-provoking opinions. The "Mine/Countermine Operations" portion of the article was undoubtedly intended to cause appropriate self-reflection in the combat engineer community and units concerning their proficiency in countermine operations. Instead, the misplaced emphasis of the article may only have destroyed soldier confidence in a good piece of equipment, the currently fielded AN/PSS-12 mine detector.

The mine danger to our soldiers is very real. Antitank and antipersonnel mines are among the most lethal munitions on the battlefield, even though much of the world mine stockpile may NOT be very "high-tech." There is not presently any fielded means of stand-off detection to allow our soldiers to locate camouflaged or concealed mines without exposing themselves to serious injury or death. There also is no non-metallic mine detector fielded or presently available to U.S. forces.

The key to our detection "deficiency" was correctly identified by the author: TRAINING. In fact, proper training is so crucial that the lead sentence in the Mine/Countermine part should more correctly read "Many soldiers have little confidence in their ability to detect any mines with any equipment currently fielded." Despite such valid concerns, however, documented recent field use on live-armed mines in Southwest Asia by civilian contractors and in Bosnia by allied peace-keeping forces indicates unreservedly that trained operators using the AN/PSS-12 successfully detected the majority of all AP mines, even those touted as "non-metallic." This was possible because even non-metallic mines generally have at least a metal firing pin which can be detected by a well-trained operator using the AN/PSS-12. The confidence level has nothing to do with the extremely capable AN/PSS-12 detector, and everything to do with the frequency and realism of the detector training conducted.

An article featuring the successful use of the AN/PSS-12 is being written and will be submitted for publication in a future edition of *ENGINEER*.

Major David A. Brown
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Picatinny Arsenal, New Jersey

Letters to the editor are welcome. They should be addressed to: Editor, ENGINEER Professional Bulletin, ATTN: ATSE-T-PD-EB, Fort Leonard Wood, MO 65473-6650.

Return to Somalia:

The Construction of Victory Base

By Lieutenant Colonel Robert L. Davis and Major Mark D. Feierstein

On 12 March 1993, the rear detachment of the 43d Engineer Combat Battalion (Heavy) departed Mogadishu, Somalia, leaving a vertical construction platoon as part of the residual engineer force. When the platoon returned to Fort Benning on 26 May, our soldiers thought their mission in Somalia was over. However, events on 3 and 4 October changed all that. After the President announced that an armored task force would be sent to Somalia to protect U.S. forces, we were alerted to deploy a company (-) to "bed down the task force." That requirement quickly grew into providing a task-organized combat heavy battalion. The following is a summary of the 43d's experiences on our second deployment to Somalia, in support of Operation Continue Hope. The article focuses on our main effort, the construction of Victory Base, a 1,700-soldier base camp.

Deployment

The battalion was alerted on 8 October, with the initial requirement to deploy a company (-), departure date unknown. The battalion staff quickly prepared Alpha Company for deployment, but within hours the requirement increased to a battalion (-). More changes followed. By change number three, the battalion staff conservatively decided to prepare for the worst-case scenario: prepare the full battalion for immediate deployment. By the end of the weekend that assumption was close to fact; our equipment was enroute to the port of Savannah by rail and commercial line haul.

Each line company deployed vertical heavy and horizontal light, taking all vertical construction assets and enough horizontal equipment to clear, grub, and build roads for the base camp. Included were two D7 dozers, two graders, two 2 1/2-cubic-yard loaders, and one small emplacement excavator (SEE) per company. Each company also deployed with eight 20-foot MILVANs with chassis to hold sets, kits and outfits, tents, and other supplies. Based on experience gained from our first deployment to Somalia, we painted 1-foot equilateral triangles on the sides of all containers, including the top, to uniquely mark them for rapid identification.

Because Class IV construction materials were not available in Somalia, the Army component of Central Command (ARCENT) contracted with Brown and Root to ship $1.7 million (about 60 MILVANs) of Class IV items. This estimate was based on our bill of materials from Operation Restore Hope. We purchased an additional seven MILVANs of Class IV material to build latrines and showers to meet the task force's immediate needs. These containers deployed with Alpha Company.

On 17 October, Alpha Company's advance party flew to Somalia aboard a C5A. The battalion's advance party and the rest of Alpha Company departed three days later on a commercial charter plane. We flew into Mogadishu on KC-10s from Cairo because the increased threat prevented commercial aircraft from landing in Somalia. The battalion's main body departed 10 November, also on commercial charter, to arrive at the same time as its equipment.

Missions in Somalia

Situation. The probability of random attacks against coalition forces or of being drawn into fighting among clans was high. Force protection was our top priority, and we continually stressed rules of engagement to soldiers before they deployed and while they remained in Somalia. When we left secure areas, we wore helmets, body armor, and load-bearing equipment and carried loaded weapons. Convoys consisted of three or more vehicles with sandbagged floors. One vehicle was a "gun truck," which was armed with at least one M60 machine gun. Redundant communication with all convoys was essential, as was reflexive knowledge of fire support, MEDEVAC, and SALUTE procedures.

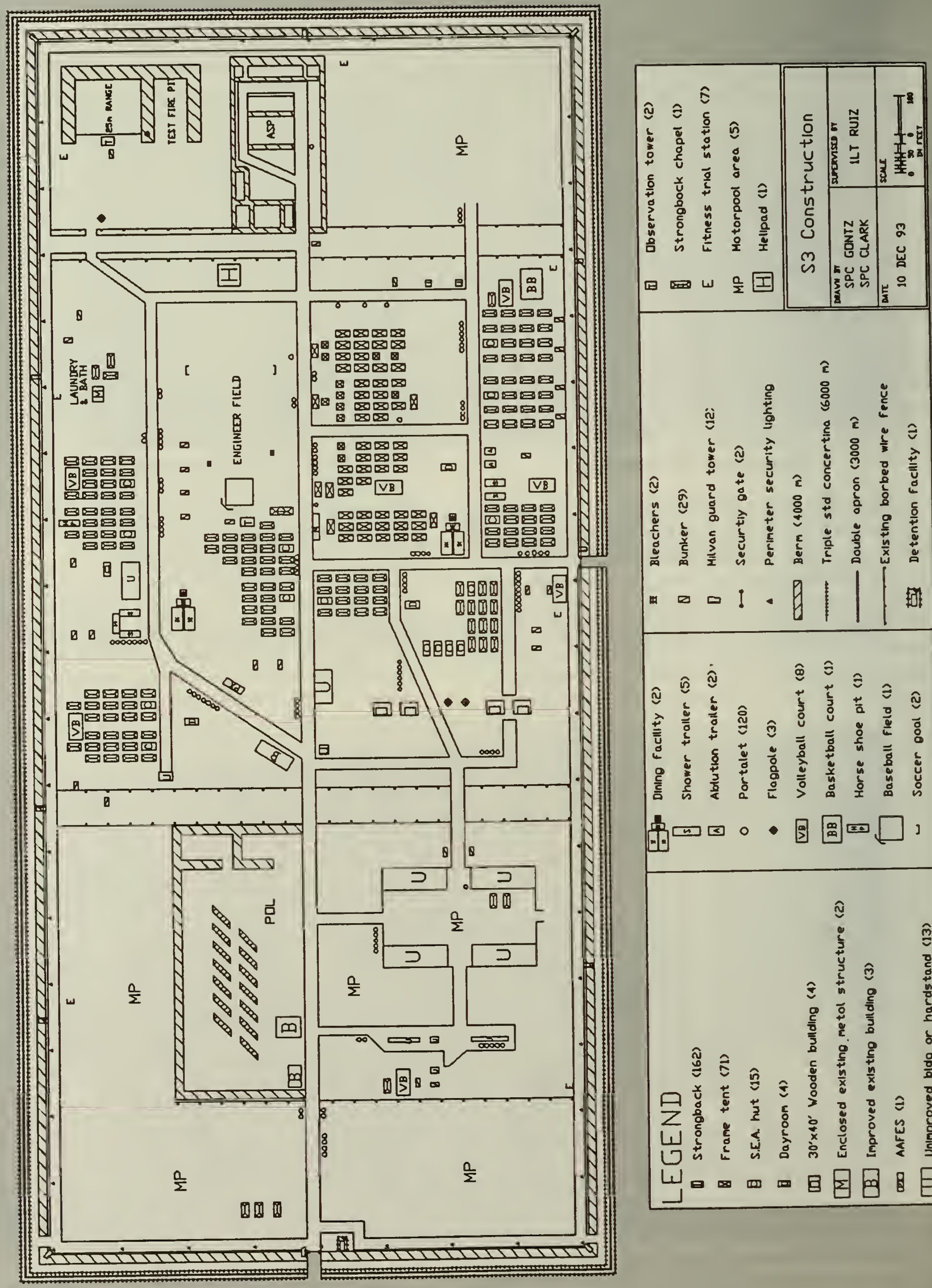
Victory Base was secured with a perimeter berm and wire network. Our innermost protective barrier was an 8 to 10-foot high berm that had an outer perimeter road directly outside for mounted patrols. The innermost ring of triple-standard concertina was just outside that road, followed by a double-apron fence and one last layer of triple-standard concertina. This dead zone was 40 meters wide, was illuminated with 3,000-watt perimeter lights placed 50 meters apart, and was overwatched by MILVAN guard towers embedded in the berm.

Inside the base camp, the enemy threat was evening 60-mm mortar attacks, so we sandbagged tents and wore helmets and body armor after dark. Because vector-borne diseases were rampant, we religiously took mefloquine once a week to sustain our health. We also used insect repellents and sunscreen, slept on cots with mosquito netting, and avoided local food and water.

Mission. The 43d was attached to the Falcon Brigade, 10th Mountain Division, which was part of Joint Task Force (JTF) Somalia. We were in direct support (DS) of Task Force 1-64 Armor to bed them down, while maximizing force protection and quality of life. Mission creep was minimal, and the

SPC Martin, SPC Fullwood and SPC Massey (left to right) of 1st platoon, B Company, level the ground prior to placing strongback footings.

43d Engineer Combat Battalion (Heavy)
Power for Service
Victory Base, Mogadishu, Somalia



PV2 Mebane of 1st platoon, B Company, marks floor joist positions on a strongback tent beam.

battalion directed almost all its efforts to Victory Base.

Task organization under the JTF, as opposed to the United Nations Logistics Support Command (UNLSC), worked well because it linked us directly to the units we were sent to support and precluded potential conflicts of interest from competing UNLSC priorities. Charlie Company, 3d Engineer Battalion, the habitually associated divisional engineer company, built Victory Base's perimeter berm and wire system. The 535th Prime Power Detachment established the electrical grid and was the only UNLSC engineer unit on Victory Base. Brown and Root provided contracted support.

Execution. A viable site for Victory Base had not been identified when the battalion advance party arrived on 21 October. The 43d Commander and S3 reconnoitered the proposed site and determined that it lacked sufficient drainage and trafficability. The search for a new site began immediately. A joint effort between the 43d and TF 1-64 identified an abandoned Soviet missile site just 3 kilometers north of Mogadishu. That site seemed perfect—it had good drainage and an existing road network, was easy to secure and defend, was just the right size, and was out of range of 60-mm mortar shells launched from the city's dingy back alleys. Falcon Brigade Civil Affairs had even concluded favorable negotiations for the land (you couldn't just take what you wanted in Somalia).

The problem was that the site contained more than 90,000 pounds of warheads and rocket propellant from abandoned missiles. The explosive ordnance detachment was immediately notified, and they determined that the ordnance was too unstable to move and had to be destroyed in place. Unfortunately, the propellant and warheads were located in the best five of ten salvageable structures.

While EOD planned the big bang, our S3 section planned construction, and Alpha Company worked at Sword Base prefabricating latrines and staging equipment from the first ship. Satellite and aerial photographs of the site were not available, so our construction officer boarded a helicopter to "shoot" some. That night he drafted a scaled layout from those images to make a planning board. We conducted detailed coordination with TF 1-64 at this point to ascertain specific needs and desires. We then made scaled vehicle cutouts and generic task force company "footprints," each of which contained 12 strongback tents and one Southeast Asia (SEA) hut, and arranged them on the board to determine optimal billeting and motorpool locations. All other base-camp facilities (showers, administrative buildings, dining facilities, bunkers) logically followed.

Once the task force was satisfied with the base layout, we completed construction estimates and assigned each of our companies specific areas of responsibility (AORs). The AORs were selected to maximize use of the battalion's resources by optimally allocating company workloads while simultaneously giving each company a wide spectrum of construction missions and training. The AOR concept was also used to promote unit pride by giving each company a sense of ownership for its assigned work areas.

The S3 wrote an operation order (OPORD) to integrate resources and clearly define, by phase of construction, exactly what needed to be done, in what priority, how, and by whom (the 43d, C/3, 535th, and Brown and Root). All changes, refinements, and additions to the base OPORD were specified in subsequent written fragmentary orders (FRAGOs). The S3 also provided designs for all work to be accomplished.

Base Construction. Victory Base was constructed in four overlapping phases. Phase I, horizontal construction, began with site occupation on 30 October, after the ordnance was detonated. It included clearing and grubbing operations (3.7 million square feet); emplacing crushed coral (880,000 cubic feet); and constructing a perimeter berm, roads, motorpools, an ammunition supply point (ASP), a test fire pit and a petroleum, oil and lubricants (POL) yard. Phase I ended on 8 December.

Phase II, vertical construction, began on 5 November with the start of the first company footprint. Before starting construction, we removed hundreds of tons of twisted metal and rubble left by EOD's blast. Force protection work included the perimeter wire obstacle system, perimeter lights, and 12 MILVAN guard towers. Quality of life construction included building 162 strongbacks (16 feet by 32 feet), 15 SEA huts (16 feet by 32 feet), and 4 SEA huts (30 feet by 40 feet), all equipped with electricity and lights; a GP large strongback tent chapel; a laundry and bath facility; and a power grid. Phase II ended on 10 December.

Phase III, bunker construction, also involved both vertical and horizontal efforts. However, it was different from Phases I and II because we executed it as assets were freed from those phases. The threat determined the priority we placed on Phase III. Phase III ended on 10 December when the last MILVAN bunker was completed.

Phase IV's purpose was to continually improve on work performed in Phases I through III and to do new projects to enhance base-camp efficiency and quality of life. Phase IV projects included a 25-meter qualification range; a detention facility; an air conditioned PX; decks, benches, and privacy screens for shower trailers; over 200 pieces of modular furniture; a fitness trail with seven exercise stations; and baseball and soccer fields complete with a backstop, goalposts, bleachers and a line chalker. Phase IV ended when the battalion left Somalia on 18 December.

Victory Base construction was a highly dynamic process. Not everything went as planned—we completed some projects earlier than anticipated and some later. There were also plenty of fresh ideas for improvements and new projects, the best of which were implemented in Phase IV. Examples include counterweighted I-beam gates and hedgehogs for base-camp entrances, SEA hut window shutters and five-roll paper holders for portalets. We expected such changes and effectively managed them while keeping workloads balanced with clear, concise mission orders (FRAGOs). Active quality control at the company level and quality assurance at the battalion level were also important to ensure that work was done right the first time. Additionally the companies, platoons, and squads learned lessons daily, which they shared each evening at the battalion command and staff meeting, to minimize learning curves.

Military engineers did not build Victory Base by themselves. Brown and Root played an integral role by providing contracted equipment, services, material, and construction. When we first occupied Victory Base, not all of our earth-moving equipment had arrived, so we relied on Somali dozers and compactors to assist with initial clearing and site preparation. Contracted Somali labor cleared brush, filled sandbags, removed waste from portalets, and disposed of trash. Somali carriers hauled most of the 880,000 cubic feet of crushed coral that we emplaced in motorpools and around company areas to improve trafficability and control dust.

Brown and Root also provided Victory Base with five 18-head shower trailers and two 3-head units with water tanks and pumps, five reefer vans, several chest freezers, ice machines, and air conditioners. Brown and Root also built two dining facilities, four dayrooms, and the base's 3-kilometer perimeter lighting system. Working with Brown and Root and their Somali subcontractors highlighted the importance of proactive civil-affairs operations when inter- and intra-clan fighting stopped crushed coral deliveries for more than a week.

The battalion executed several smaller missions while constructing Victory Base. They include work performed at the boat factory, the JTF Headquarters, Checkpoint 31, Gotham City and the Mogadishu Airport. The boat factory was an abandoned works on the coastline southwest of Victory Base. We prepared it for occupation by friendly forces by clearing it; establishing drainage; wiring two existing warehouses and an administrative building for electricity; and constructing a dining facility, six guard towers, two bunkers, a 25-meter range, a test-fire pit, and several berms. We built bunkers, mortar-blast shields, and tent floors for the JTF Headquarters; constructed a guard tower at Checkpoint 31; and cleared a holding area for Somali refugees near Gotham City. Finally, at the airport, we conducted site preparation for future construction, waterproofed the terminal roof to increase usable space in the passenger holding area (PHA), and built picnic tables for use in the PHA.

Each company footprint contained one SEA-hut for administration. B Company built this one for Cobra Company, Task Force 1-64 Armor.

Service Support. With the exception of Class IV, assistance from Brown and Root and laundry and bath service (furnished on-site by the 16th Field Service Company, UNLSC), the 224th Forward Support Battalion (FSB) provided all the battalion's logistical support. The 224th was attached to TF 1-64 and received its support from the UNLSC. The theater had matured considerably from the time of our first visit and, excluding Classes IV and IX (repair parts), obtaining routine support was no longer an ordeal. Construction material shortages were recognized, which is why ARCENT furnished our Class IV. Repair parts nonavailability, especially for low-density engineer equipment, was just as broken as during Restore Hope. Units in country could more easily acquire Class IX by calling back to home station than by requisitioning it in theater. Even though we were in Somalia a total of only two months, the Class IX situation was so desperate that our group commander brought all the parts he could carry when he came to visit.

Command and Signal. Confusing theater command relationships made routine duties much more trying than necessary. Our task organization under the JTF and Falcon Brigade greatly clarified our mission requirements, but the lack of a theater engineer made engineer coordination outside of the JTF difficult and burdensome. Out of frustration and the desire to facilitate our work, we met weekly with all key engineers in country. This was very successful in that it expedited actions, corrected miscommunications, and prevented duplications of effort.

The battalion experienced many communication challenges during Continue Hope. Single-channel, ground airborne radio systems (SINCGARS) were our organic and primary means of communication. We operated in single-channel mode because many U.S. and all allied units could not frequency hop. Although we had no organic mobile subscriber equipment (MSE), we employed devices borrowed from other units. Five mobile subscriber radio terminals were used throughout the battalion. Nine digital, nonsecure voice terminals were used at Victory Base for operational control and morale, welfare, and recreational purposes. We used a UXC-7 secure tactical facsimile device to send and receive classified situation reports (SITREPs), OPORDs, and FRAGOs to and from Falcon Brigade Headquarters at the embassy.

Two electronic-mail tactical terminal adaptors allowed us to send unclassified reports to other headquarters and to update our rear detachment and family support-group network at Fort Benning. These daily progress reports were recorded on a Somalia hotline that the battalion's friends and family members could access by dialing a toll-free (800) number. Commercial hand-held and AN/PRC-127 radios facilitated communication between the battalion tactical operations center and worksites. A TA-312 network provided reliable and redundant communication in the base camp. The major problem that persisted to the very end was the apparent lack of compatibility between the digitally grouped multiplexed (DGM) system and MSE. This problem plagued not only the 43d, but all of Victory Base. All other communication challenges were surmountable.

Redeployment

The battalion completed the enormous task of constructing Victory Base in a little over two months after our initial alert in garrison. Due to the drawdown of U.S. forces in theater, we turned much of our engineer equipment over to Brown and Root. We transferred our remaining Class IV to the 224th FSB, and provided Brown and Root with a memorandum delineating base-camp maintenance requirements. As we prepared our remaining equipment for shipment, we experienced one final reminder of Somali hospitality: Aidid strongholds in the city forced us to convoy on a circuitous route from the washracks to the port along a dusty main supply route. The battalion returned to Fort Benning on 19 December.

Lessons Learned

We learned many lessons during Operation Continue Hope. Some carried over from our first Somalia deployment and were reinforced, while others were specific to this deployment.

- Make force protection your number one priority. It should drive all planning and execution and is ultimately achieved through continuous command emphasis. It ranges from base-defense planning that is commensurate with the threat, to squad leaders ensuring that their soldiers keep their flack vests closed while on long, hot convoys.
- Distinctively mark containers before shipping to facilitate recognition at destination. Mark all sides and the top with a symbol that can be seen from a distance.
- Try to find out about Class IV availability. You may have to bring your own. If you don't, you may end up sitting in theater waiting for materials. Ship it in 20-foot MILVANs with chassis to ease transportation. Deploy with a supplementary, command-directed prescribed load list, especially for low-density equipment, based on anticipated missions and theater conditions, such as hot, dusty roads and jagged rocks.
- If you can influence task organization, try to work directly for those you will support to preclude competing priorities.
- Ensure you understand your customer's needs and desires and meet often to stay attuned to them. Once you know your customer's expectations, use scaled site layouts, OPORDs, and FRAGOs to manage the details and maximize efforts so you can exceed those expectations. Use these tools to avoid mistakes and wasted effort, even if there is pressure to produce quick results.
- Bring any special tools you think may help. For example, pneumatic nail guns are great when you have a lot of carpentry work, and a K-SPAN machine is the most efficient way to roof most existing structures.
- Perform meticulous quality control and quality assurance to catch mistakes early. Share lessons learned at all levels daily.
- Use contractors for whatever you can, whenever you can. Start planning the engineer end state early by focusing on transition to the contractor when possible. When you do transition, do so clearly and in writing. Until you put it in writing, you probably haven't thought it through. Be aware, however, that civil disturbances and unrest can hinder or even stop contracted support so have a strong civil affairs program and back-up plans.
- Finally, meet at least weekly with fellow engineers in theater, military and civilian, to synchronize efforts.

Conclusion

The true keys to the phenomenal success of the 43d Battalion during its second trip to Somalia were the speed and versatility of construction in support of combat operations. The experience gained from the first deployment allowed the battalion to exceed all task force expectations and safely redeploy soldiers once the mission was accomplished. The lessons learned will serve engineers well in the future and help ensure that we represent the Corps with distinction, by continuing to prove that engineers are vital to the Army in its changing roles.

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Major Mark Feierstein is currently the battalion S3 for the 43d Engineer Battalion. He previously served in the 36th Engineer Group Headquarters, the 7th Engineer Brigade, and as the engineer team chief at Readiness Group Snelling. A CGSC graduate, he holds a bachelors degree from Kansas State University.

Let's Really Train to Project the Engineer Force!

A "woe be us" lassitude seems to have struck the active duty Army engineer force as budget realities keep engineer units locked up at home station. Yet, along the United States' southwest border, requirements for engineer support provide tremendous opportunities for engineer leaders to conduct realistic, rugged training in a real threat environment, at no cost to their own training budget. Aggressive unit commanders can accomplish more METL (mission essential task list) training on a 60-day deployment to the southwest border than they may realize in a year at home station.

Changing Mission Requirements

Professional military journals continue to chronicle the changing nature of military operations. The changing face of threats to national security has spawned the doctrine of operations other than war (OOTW). In some respects, OOTW is similar to low intensity conflict in that those engaged in it, and taking rounds, may find it anything but low intensity or unwarlike.

Changing doctrinal emphasis has also intensified the necessity to project the force into regions where it is needed. We no longer have the luxury of massive, in-place forces. We must rely on the speedy and efficient deployment of forces, whether overseas or to disaster spots in CONUS.

Counterdrug operations along the southwest border of the United States are an important part of the OOTW mission that supports national security interests. The southwest border region is a designated high intensity drug trafficking area and support to counterdrug operations in this area is one of the five key elements of the national drug control strategy. For the past four years military engineer units have made great contributions in this effort while supporting law enforcement agencies along the border.

Fumbled Training Opportunity

Unfortunately, recent military engineer contributions have been without Army engineer unit participation. Force drawdowns, downsizing, split-stationing of units, and budget cuts have caused Army engineer units to become decisively engaged in post and installation construction and maintenance activities. A look at the fiscal year (FY) 94 JTF-6 engineer mission program reveals that for the last two and one-half quarters of the FY only one active duty Army engineer unit has volunteered for a southwest border deployment. The counterdrug engineer construction mission is quickly becoming an air and sea service show.

Army engineers are missing tremendous opportunities to engage in meaningful training in an area desperate for their support. JTF-6 missions offer excellent opportunities for units to gain critical training in deployment and redeployment activities, logistics planning and execution, and construction. These opportunities are available at virtually no expense to employed units or their parent headquarters. JTF-6 assumes the costs for transportation, rations, fuel, and operating costs associated with a southwest border mission. Units can augment their training program, gain valuable METL training, and execute meaningful engineer missions at no expense to themselves.

Training Focus

Engineer support focuses on improving interdiction capabilities of law enforcement agencies through repair and construction of border fences and patrol roads. A secondary focus of construction missions is to optimize the number of law enforcement agents on patrol by building close-in firing ranges and enhancing existing facilities. Engineer missions in support of law enforcement agencies run the spectrum of complex to simple and offer a variety of mobility, countermobility, and survivability tasks. Typical missions executed on the southwest border range from barriers/obstacles (border fences of various styles and designs), construction and repair of combat trails and roads,

(Continued on page 33)

By Lieutenant Colonel Mark A. DeHarde

ENGINEER THEATER SUPPORT OPERATIONS

By Jeb Stewart

The Army's Role in Containment

From 1946 until 1991, the strategic security policy of the United States was "containment"—containment of the Soviet Union, its surrogates, and the spread of world communism. Since 1950, about half the U.S. Army has been positioned in Europe to thwart Soviet designs on western Europe. For decades, many USAREUR units were stationed almost where they were when the fighting stopped in 1945. And, until quite recently, operational-level thinking and many Army support structures reflected the World War II experience.

In 1991, containment was finally victorious. Facing intolerable pressures, the Soviet economic system collapsed and with it the Soviet military empire. The war of the giants had been averted, but frustratingly, the quarrels of the pygmies have intensified. Now our Army is coming home, downsizing, and learning how to protect vital national interests abroad by developing more deployable forces that can meet the realistic goal of dealing with two almost simultaneous, major regional crises. Our now-obsolete doctrine was developed with a global threat in mind; its basic premise was the defense of western Europe. Doctrine is now being rewritten as fast as possible to reflect and support our new security needs. Among the doctrinal challenges facing the Engineer School is the preservation of a central core of doctrinal substance as we rewrite our doctrine or participate in other proponents' doctrinal development process. Many talented writing teams are hard at work on this immense task. Unfortunately, the possibilities of inadvertent conflicts in doctrine or substantive errors are quite high.

Core Guidance

To articulate the core guidance and to serve as the intellectual precursor for subsequent doctrinal publications, the Engineer School has developed a white paper that describes engineer theater support operations. This paper describes in specific terms how theater U.S. Army engineer field organizations will respond to various contingency requirements with a mix of military and contractor capabilities and how the U.S. Army Corps of Engineers (USACE) will be integrated into this effort. This article is an abridgement of the white paper. It describes what must be done to fill the doctrine and force design "gap" and discusses engineer organizations that are designed or can be adapted for theater support operations and the inclusive missions they may have to perform.

The White Paper

The current national military strategy envisions a response to regional crises with a mix of rapidly deliverable and initially self-sufficient forces. The unified commander (CinC) may assign a single service to respond or, more likely, may select from a broad spectrum of capabilities from all services and tailor a joint task force. The U.S. Army contribution to either option may be a brigade, a division, a corps, two or more corps or a task force organization of any size. This force must have the capability to operate for a notional 90-day period without the theater support structure described in current doctrine.

Some critical engineer missions are currently staffed for planning only at theater level. The absence of early-on theater engineer support could jeopardize missions to a degree that is not clearly understood outside the engineer community. If a corps is deployed, under current doctrine the troop list typically includes a corps engineer brigade headquarters and several engineer group headquarters along with engineer troop units. If a division or a brigade is deployed, only those organic engineer elements (engineer brigade for heavy

Theater Support Engineer command and control elements

Size of force	Geographical size and complexity of theater engineer mission			
	Large/mature	Large/immature	Small/mature	Small/immature
Multicorps	ENCOM	ENCOM	ENCOM	ENCOM
Single corps	ENCOM/ TA Bde	TA Bde	TA Bde	TA Bde
Division	Corps Bde/ Group	Group	Group	Group
Brigade	Group	Group	Group	Group

divisions, engineer battalion for light divisions and a battalion slice for a heavy maneuver brigade) are normally included in the troop list.

All these elements are focused on combat engineering in combined arms operations and have a limited capability for "theater support" engineering. In most conceivable scenarios, the combat engineers will be unable to cope with requirements for construction engineering and related services. Theater support engineering will almost certainly be conducted jointly with other U.S. service components and probably combined with our allies. Engineer topographic support (other than divisional terrain teams) is provided by engineer topographic units found in theater and corps support structures.

Reliance on Reserve Components

An important assumption is access to critical engineer theater support skills that reside either predominately or exclusively within the Reserve Components. The resolution of certain mobilization issues, the discussion of which is outside the scope of the white paper, is of vital importance to the engineer force.

Focus of Engineer Operations

At theater level, the engineer and the logistician share numerous interests; they are equally concerned about such matters as logistics base construction and the maintenance of supply routes. Their concerns are often considered so closely related as to tempt planners to combine their command and control structures. However, such a policy works to the pronounced detriment of the theater commander's ability to execute his campaign plan, which requires a flexible engineer task organization to achieve operational objectives.

In addition to supporting forward commanders, engineer forces are responsible for constructing, maintaining and rehabilitating the theater support base. The theater army (TA) commander tailors the engineer structure to theater requirements. Establishing a theater base depends heavily on the extent and nature of the civil and military infrastructure existing in the theater before hostilities begin. All engineer units (combat, construction and topographic) are focused on actions at the operational "tip of the spear."

While they fully support logistical requirements, engineers must not be rolled into the theater logistics support structure. Theater engineers are often employed in reinforcing combat engineers organic to the corps, divisions, separate maneuver brigades and cavalry regiments. The senior engineer commander ensures that all engineer battlefield functions are fully planned, integrated, synchronized and executed to support the maneuver commander's intent and scheme of maneuver. Engineers must be full participants in current and future operational planning and have their own command and control headquarters to ensure the timely and proper execution of the intent and scheme of maneuver.

The senior engineer commander in a theater of operations may be responsible for any or all of the following missions:

- Planning and coordinating combat operations.
- Engineering assessments of theater infrastructure requirements.
- Planning, coordinating, and supervising military and contract engineer support to the Army, other services and coalition forces in the theater.
- Allocating engineer resources (units, contractors, materials, and equipment) to meet mission requirements.
- Prioritizing the use of available theater engineer assets to include tradeoffs between combat and construction requirements.
- Coordinating topographic and military geographic intelligence support to the force.
- Providing real estate support to the Army, other services, and allies throughout the theater.
- Providing technical assistance to real property maintenance activities (RPMA) throughout the theater.
- Planning construction material requirements and prioritizing their use.

Engineer command and control headquarters with theater support capabilities include:

- Engineer Command (ENCOM).
- Engineer Brigade (Theater Army).
- Engineer Brigade (Corps).
- Engineer Group.

The central organizational framework for theater support operations is the theater army, of which an ENCOM is a major subordinate element. There are two ENCOMs in the current force structure; both are U.S. Army Reserve units. Each ENCOM is focused to support one of two major regional contingencies occurring simultaneously. An ENCOM normally consists of one or more engineer brigades (theater army), at least one topographic battalion, and several other specialized engineer units. The ENCOM structure was designed to support a multi-corps theater and represents prudent force planning for a major regional contingency. During lesser regional contingencies, the ENCOMs are a source of highly trained professional engineers and support personnel who can deploy incrementally as necessary to augment other engineer staffs.

The TA engineer brigade consists only of a headquarters and headquarters company (HHC), with all other subordinate elements assigned based on METT-T considerations. The TA engineer brigade may have a number of engineer group headquarters, engineer battalions, companies, detachments, and teams. The TA engineer brigade area of operation (AO) normally coincides with the theater army area command (TAACOM) boundaries. During contingency operations, the TA engineer brigade, augmented from the ENCOM or USACE, can deploy and serve as the theater's senior engineer headquarters.

The corps engineer brigade commands and controls the combat engineers in the corps troop list and other engineer units task-organized under the control of the corps commander. Although not designed for theater-level engineering, as an early deployer the corps engineer brigade often gets the responsibility anyway. The corps engineer brigade requires augmentation from the TA engineer brigade, ENCOM or USACE to execute theater support missions.

The engineer group has an organic HHC and can provide command and control for as many as seven engineer battalions, plus a number of separate companies, detachments and teams. The engineer group is the principal subordinate unit of an engineer brigade. The two types of engineer groups are the combat group and the construction group. The primary difference is the size of the construction management section (five soldiers in the combat group, 17 in the construction group). The engineer group functions as the principal manager of engineer combat forces or as the construction manager for a given area or specific tasks and has planning and design capabilities. For maneuver brigade or division-level force contingencies, the group may be utilized as the command and control headquarters for engineer theater support.

Engineer Theater Missions

Planning and coordinating combat operations. Theater engineer units conduct combat operations by providing mobility, countermobility, survivability and topographic services to maneuver units. Missions include replacing assault bridging with support or lines of communication bridging, clearing minefields and removing other obstacles, maintaining main supply routes and constructing heliports and airfields. Topographic support includes mobility "go/no go" overlays and geodetic survey products.

Engineer assessment of theater requirements. Combatant commands maintain libraries of information on countries within their AO which the CinC has identified as potential contingency areas.

Engineer assessments describe the countries' infrastructure, including ports, airfields, soils and topography, construction materials availability and civilian construction industry. This information is useful but does not have the level of detail or accuracy required for thorough construction management planning. The first arriving engineer command and control element will determine macro requirements and report their initial observations. This first-arriving engineer command and control element will likely be a combat engineer element and will lack the staffing or expertise to do construction management planning. The first-arriving engineer element may be able to conduct an initial assessment but will be unable to plan or execute missions to correct theater-wide engineering deficiencies. This element will likely require augmentation to plan theater-level engineering regardless of the size of the theater of operations.

Planning, coordinating, and supervising general troop and contract construction or rehabilitation support to the Army and other services and allies within the COMMZ and construction support in the corps areas. The engineer supports the theater of operations through construction of new facilities or repair or modification of existing facilities. Wartime facility requirements will be satisfied, in order of priority, by—

- Maximum use of existing facilities (US- or host-nation controlled).
- Modification of existing facilities rather than new construction.
- Expedient and initial standard construction and site preparation necessary for emplacement and operation of unit equipment and bed-down of troops.
- "Temporary" standard construction.

The CinC establishes broad construction policies and standards and designates a staff engineer, who may be from any service. To assist this engineer, the CinC may establish a regional contingency engineering management (RCEM) cell. This cell provides policy interpretation, oversight and project prioritization recommendations. The RCEM cell does not have command and control responsibility. Command of Army engineer theater-support forces rests with the senior engineer commander, normally the ENCOM commander, who may wear a second hat as the regional contingency engineering manager. The mission of the regional contingency engineering manager may include the following:

- Set construction priorities and policies based on CinC's guidance.
- Allocate force construction capability.
- Balance engineer support to operational and logistical requirements.
- Manage construction materials.
- Plan for future construction.
- Program construction funding requirements.

Allocating engineer resources (units, contractors, materials, and equipment) to missions. The senior engineer headquarters will allocate scarce resources and adjudicate among claimants. The requirement may fluctuate significantly between mature and immature theaters. For example, during Desert Shield, 26 of the 29 engineer battalions in the theater were assigned to the two corps engineer brigades because much of the rear infrastructure was already in place.

Missions can be executed by troop units, host nation, or contracting. Engineer services include but are not limited to hazardous waste and waste water disposal, trash removal, maintenance services, construction equipment/operator services, and firefighting. Contingency force operations may have an austere combat service support base and will require contract-provided services and supplies. The use of large, multifunctional civilian contractors, LOGCAP (Logistics Civil Augmentation Program) to perform various theater-support engineering jobs is usually desirable and may be feasible in many overseas areas. The Corps Support Command (COSCOM) or Division Support Command (DISCOM) will operate a contracting element to provide contracting support. When a full corps or a complete division is not deployed, the COSCOM or DISCOM may provide a contracting task force tailored for the specific contingency operation. The RCEM cell will determine the need for and availability of engineer services contracting.

Prioritizing the use of engineer assets. The senior engineer will be tasked to refine the notional time-phased force deployment list (TPFDL) to more closely match existing requirements with capabilities. Focusing on the campaign plan, the senior engineer commander must make tradeoffs between combat and construction engineering. Sometimes, despite the versatility of the engineer force, this process results in apparent "square pegs" as units temporarily perform missions for which they are not trained or equipped in anticipation of future requirements for work in which they are. This concept outlines the use of selected ENCOM elements and their entry into the deployment stream through the process of force modularity.

The ENCOM will provide a construction management cell to the senior deploying engineer element. This Army reserve cell will train in peacetime for ENCOM or contingency force engineer missions. The cell will be quickly called to active duty for deployment during contingency operations.

Early deployment is critical because the cell will be involved in force reception and bed-down. The cell will become the senior engineer commander's construction management staff. It will be equipped with and trained in the use of an automated construction management system (for example, the developmental Theater Construction Management System or a similar system). If and when the theater matures and the ENCOM deploys, the ENCOM and brigade commanders will coordinate a hand-off of construction management responsibilities.

Coordinating topographic and military geographic intelligence support to the force. Commanders planning or executing contingency operations will require accurate, timely, and tailored topographic engineering products in order to visualize, operate on and exploit their battle space. Topographic engineers will provide critical mapping, charting and geodesy (MC&G) support and products during contingency operations. Contingency operations may occur anywhere on earth, and surprisingly little of the earth's surface has been accurately mapped. Contingency operations frequently occur, as if with malicious intent, in sparsely mapped areas. Topographic engineering support will provide operational and tactically oriented terrain analyses, nonstandard and substitute maps, and survey data to combat, combat support, and combat service support forces in all phases of operations throughout the contingency area. The Defense Mapping Agency (DMA) will be responsible for producing all standard MC&G products and data bases.

Throughout the operation, topographic engineer planning and control elements will process and refine topographic information passed between deployed forces and DMA. Some terrain features may change rapidly once operations begin; others may be unaltered by operations. Knowledge of the terrain will rapidly increase as a result either of focused study or on-the-ground reconnaissance. Topographic engineers will maintain qualitative information concerning coverage, resolution, standards, source, currency, accuracy, uncertainty, and limitations of all topographic data. They quickly replace older, superseded data to ensure that users are provided the most current data available. This support includes passing provisional or locally acquired data back to DMA for possible exploitation as DMA updates and maintains its standard data bases and products.

The commander of the topographic engineer battalion identified within the OPLAN/CONPLAN/-OPORD to provide topographic engineer support will command all topographic units involved in the operation. The topographic engineer battalion provides general support to unified and specified commands and to subordinate topographic units for requirements beyond their capabilities, and provides topographic support to all theater Army units. The senior engineer commander will serve as the theater topographic engineer and, as such, will recommend the size, composition, support relationships, and location of the topographic engineer force.

Topographic support may require augmentation by an ad hoc rapid-response terrain team to ensure the proper level of support. The ARFOR command MC&G officer will request and coordinate the formation of a team based on the urgency and quantity of the support required. The team will be developed from reserve units, topographic units not deployed, and technical experts from Army laboratories and MC&G production agencies. Its mission will be to help deployed forces develop a detailed topographic data base quickly to allow development of required MC&G products. Deployed topographic units will continue to seek host-nation and all-source intelligence data to provide required MC&G products and enhance the force capability.

Providing real estate support to the Army, other services, and allies throughout the theater. The US Army Corps of Engineers (USACE) is the Army's real estate agent for acquisition and disposal of real property and is capable of providing real estate services for all services. During combat or contingency operations, the Chief of Engineers discharges his real estate functions through the theater commander. The work is actually done by the ENCOM, but if an ENCOM is not deployed, it may be done by the senior engineer headquarters with augmentation support. The ENCOM's contingency/wartime CAPSTONE organization includes Army engineer real estate (AERE) teams. These teams may provide general support to TAACOM in order to conduct real estate operations within a designated area. To support Operation Desert Shield, we needed an immediate in-country real estate contracting capability before the ENCOM was activated and deployed. This concept codifies many of the successful doctrinal improvisations from Operation Desert Shield and Operation Restore Hope that can be applied in future force projection operations.

USACE will provide a contingency real estate support team (CREST) for deployment as part of the contingency force. The CREST personnel will be predesignated volunteers who possess the requisite knowledge, skills, and abilities to successfully accomplish all tasks. They will maintain passports, immunization certificates, and other documents necessary for quick deployment and will have the required training to operate in a combat theater environment. The USACE CREST will participate in the annual training of the ENCOM personnel and their AERE teams so that improved training and close working relationships are achieved prior to operational deployment. The USACE CREST and ENCOM AERE personnel will review OPLANs for real estate impacts and provide recommendations to the planning headquarters. Among the areas reviewed will be level of infrastructure development and facilities leasing ceilings for potential operational areas.

When the contingency force deploys, the USACE CREST deploys and serves as the real estate cell. The CREST is attached to the senior Army engineer headquarters in theater. If the campaign develops a theater-level structure, this cell will become a staff element to the theater engineer. Among the duties of this staff element are:

- Provide technical real estate guidance and advice to the contingency force and/or theater commander, staff and all echelons of the contingency force and theater command.
- Recommend real estate policies and operational procedures to the contingency force and theater logistics officer.
- Acquire, manage, dispose, administer payment of rents and damages, handle claims and prepare records and reports for real estate used within the contingency force area or theater of operations.
- Exercise staff supervision over real estate operations of subordinate Army commands and provide real estate support to other U.S. services.
- Ensure compliance with international agreements and the laws of land warfare.
- Direct processes for seizure, requisition, or lease of real property in liberated or occupied countries.

If and when the theater matures and a Reserve Component ENCOM deploys, the USACE CREST will become OPCON to the ENCOM. The AERE teams, when employed, will conduct real estate operations in conjunction with the USACE CREST according to the theater real estate policy. The AERE teams' duties are:

- Acquire, manage and dispose of real estate.
- Investigate, process and settle real estate claims.
- Conduct utilization inspections.
- Conduct real estate operations forward of the COMMZ.

As combat subsides and forces begin returning to CONUS, real estate functions will be conducted by the USACE CREST as the ENCOM AERE team is redeployed.

Providing technical assistance to Real Property Maintenance Activities (RPMA) throughout the COMMZ. Principal RPMA functions in a theater of operations include the repair and maintenance of facilities and utilities, fire prevention and protection, and refuse collection and disposal. RPMA is the responsibility of the TAACOM or area support group, who look to a senior engineer (normally a TA brigade or a group) for technical assistance and support that are beyond the capability of their attached engineer element. RPMA work typically involves host-nation support and local contractors; however, active military operations may limit the feasibility of this option.

Managing selected construction material stocks. Engineers look to a corps or division materiel management center for most of their Class IV construction materials. Adequate Class IV supplies and timely delivery of the materials to the work sites are key to mission accomplishment. Materials typically include nails, ready-mix concrete, concrete building blocks, lumber, plywood, wire, pipe, fittings and hundreds of other "hardware" items. During initial contingency force operations, we may buy most of our Class IV requirements on the local market. We can expect little mission sealift or airlift space to be allocated for construction materials, especially in the early phases of an operation. Complete reliance on locally procured materials will be challenging. Some items may be scarce, and some manufactured items will differ significantly from U.S. building codes specification items. Dimensional materials may be cut metrically or rough-hewn.

Engineer participation in construction material purchasing is key to adapting and substituting local materials. Engineers must identify requirements with considerable specificity (including acceptable substitutes) and work with the logistics support unit to develop a delivery plan that gets the required materials to the right place and in time to keep engineers working. The COSCOM, DISCOM, or the area support group will direct a survey of the local construction material market, identify potential sources of Class IV materiel, and open blanket purchase agreements with local vendors. Engineer unit S4 officers will be appointed ordering officers to execute purchases against these agreements and will maintain a stockage of high demand items. Scarce items will be managed by the senior engineer commander. Subordinate engineer commanders will report on-hand quantities of all construction materials (Daily Logistics Report). Stockpiled materials are subject to cross-leveling. Consideration should be given to pre-positioning selected Class IV materials and/or identifying "basic load" of these materials to accompany early deploying engineer units.

The Future

Doctrine determines how engineers think about waging war and drives weapons and systems design. Doctrine incorporates the equipment and weapons of war and the cultural strengths, weaknesses and values of an army and its society into coherent concepts of how to conduct a battle. Doctrine helps soldiers and their leaders act in the absence of detailed instructions that would require continual restatement for different situations. Sound doctrine, intelligently applied to the circumstances, can have a profound, even war-winning effect on an army's performance. Doctrine formulation is a continuous process, reflecting the changing calculus of geopolitical and "break-through" scientific events. Obsolete doctrine, especially when rigidly applied, can have a disastrous effect.

By articulating our core values and vision in white paper form, the Engineer School is providing both an azimuth for coherent doctrine development and a starting point for debate within the engineer community. We need the experiences and thoughts of our engineer senior leadership. Because the impact of engineer work upon theater support operations is not fully understood outside the engineer community, many of our unique concerns may be overlooked unless we speak up as the Army wrestles with all the implications of force projection from CONUS. We urgently need your help if we are to make our positions heard.

Comments are appreciated and the mode is unimportant. Write: Commandant, USAES, Attn: ATSE-CDB-S (Stewart), Fort Leonard Wood, MO 65473-5000; call (314) 563-4083; or send via PROFS: WOO1 (STEWARTJ). Your input can help us formulate dynamic doctrine to carry the engineer force into the 21st century and beyond.

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The ENGINEER Writer's Guide

We think engineers take a special pride in their profession, and ENGINEER is always looking for articles from readers who want to share their expertise, experience and ideas.

If you're a potential contributing writer, here are a few "writer's guide" tips that should help steer you in the right direction:

Articles can cover engineer training, operations or doctrine, engineer equipment, history, or other areas of general interest to an engineer readership.

We're especially interested in articles that have a "how-to-do-it-better" theme. For instance, we're not looking for articles telling readers how you conducted a routine field exercise. But if you think you have a "new-and-improved" way of conducting a tactical operation, training exercise, or other operational procedure that may prove helpful to other engineers—that's what we need.

Articles should generally come from contributors with firsthand experience with the subject being presented. Avoid theatrical writing styles like: "It was a dark and stormy night...," or "...the soldier blazed through the jungle on his lumbering D7, providing a trail of freedom for the other vehicles...."

Articles should be concise, straightforward, and in the active voice.

Length should range between 2,000 and 4,000 words, and the text should be typewritten and double-spaced. Generally, each such page will contain from 200 to 250 words.

Articles containing attributable information or quotations not references within the story should carry appropriate footnotes.

Manuscripts must be original, unpublished, and not under consideration by another publication. Normally, you can expect a reply to your submission within two weeks after we receive it.

All submissions are subject to editing.

Contributors are encouraged to include black-and-white photos, artwork, and/or line diagrams to help illustrate your article.

Include your full name, rank, current unit and job title. Also include a list of your past assignments, experience and education, your mailing address, and commercial daytime phone number. Send your articles to: Editor, *ENGINEER* Professional Bulletin, ATTN: ATSE-T-PD-EB, Fort Leonard Wood, MO 65473-6650.

If you have any questions about an article you're working on—or considering writing—give our editor, Catherine Eubanks, a call at Autovon 676-4104, or commercial (314) 563-4104.

We look forward to hearing from you. P.S. *ENGINEER* welcomes response from our readers. Letters regarding information in our magazine are published in our "Letters to the Editor" department. Let your thoughts be heard.

Lessons Learned:

Operations Other Than War

By Major Bill Breyfogle

As an engineer commander, you and your staff have been closely watching a developing situation. Knowing that you may be deployed for an operation other than war mission, you have done some homework and are prepared for almost any contingency. Your personnel are familiar with the mission's requirements and you have reviewed the appropriate regulations and manuals. Most importantly, your dynamic staff have gone the extra mile—they have dug through the "lessons learned" from previous operations. Now you stand ready to deploy.

Operations other than war (OOTW) cover a wide spectrum of missions, from disaster relief and humanitarian assistance to peacekeeping, but some lessons learned ring true through them all. This article addresses lessons from a variety of OOTW missions; they are organized into phases experienced in most force projection operations.

Predeployment

Engineer Assessment. Early in all OOTW missions, commanders must conduct an accurate engineer assessment to determine the engineer effort required. For some missions this is fairly easy. Identifying the priority of effort for a peacekeeping mission, for example, is similar in many ways to the engineers' normal war-fighting support mission.

Disaster relief operations, however, present very different challenges. Lessons from recent disaster relief operations show that the priority of effort must include the needs of local governments. Commanders and staff must work with the local civilian leadership early in the process to establish work priorities. Local fire, police, water, sewage, electrical and telephone service agencies all play critical roles in re-establishing order and control. Be sure to also consult relief agencies such as the Red Cross, Salvation Army and United Way to help identify priorities.

LESSON: Conduct an accurate "on-the ground" engineer assessment to identify personnel and equipment requirements and priorities of effort before the main body is deployed.

Center of Gravity. Determining an operation's "center of gravity" is important to the success of every OOTW mission. For peacekeeping operations, the center of gravity may be opening main supply routes, controlling key terrain, or maintaining boundaries that separate belligerent forces. For a disaster relief operation such as Hurricane Andrew, it was opening the schools. The simple fact of children returning to school established an atmosphere of normalcy that showed the local population that things were getting better.

LESSON: For every OOTW, determine centers of gravity that help focus mission accomplishment.

Maps. Regardless of the type of operation, don't overlook the importance of timely topographic support. During disaster relief operations it is crucial to establish one specific map or map series for operations. This may be a standard U.S. Geological Survey (USGS) map sheet, a city or county map sheet, or even a realtor map. Whenever possible, planners must be proactive in identifying required topographic products before they are needed during crisis actions. Units alerted for deployment to theaters without standard map coverage must quickly identify their topographic requirements and pass them through their respective operations channels for validation.

LESSON: Identify and pass standard map and other topographic product requirements through operations channels as quickly as possible, either before a crisis occurs or early in the response effort.

Deployment

Take It All! It is critical that units deploy with all of their equipment! While this seems obvious, many units have deployed recently without their full table of organization and equipment (TOE). Examples include engineer units that deployed for Operation Just Cause without taking demolitions, and engineer units that deployed for Hurricane Andrew relief operations without such basic debris-clearing tools as chain saws. Units that fail to deploy with all personnel and equipment may seriously hinder their ability to provide critical engineer support to the commander; this failure may ultimately jeopardize overall mission accomplishment.

LESSON: Deploy with your entire range of engineer personnel, equipment and supplies and be prepared to provide flexible and versatile support.

Class IV Supplies. Many past OOTW demonstrate that Class IV supplies were critical to successful mission accomplishment, but often those supplies were delayed due to low shipping priorities. These experiences show that units need to preposition and stockpile critical Class IV items in possible force projection theaters, especially when deploying to austere environments. Follow-on airlift and sealift shipments should include frequent loads of the Class IV items required to support follow-on operations. By stockpiling supplies and ensuring the steady flow of Class IV items into the theater, units can avoid problems associated with large bulk supplies taking up critical space on ships.

In some recent operations, the problem was not so much in obtaining Class IV items as it was in controlling the storage and issuing the supplies. A solution that worked well in some cases was to make an engineer the S4 or liaison officer to help identify, order, store and distribute Class IV materials.

LESSON: The success of engineer support to OOTW is closely associated with the availability of Class IV materials. Leaders must be proactive to ensure that required Class IV materials are on hand when they are needed.

Entry

Rules of Engagement and Force Protection. Force protection in any OOTW mission requires units to follow appropriate rules of engagement (ROE). Units training for OOTW missions usually need extensive training on the application of the ROE. Engineer soldiers should reinforce the tactics, techniques and procedures for situations they expect to encounter when executing OOTW, such as how to execute a road block or checkpoint and react to sniper fire or an ambush. When engineer units deploy for disaster-relief missions, they are often called to assist local law-enforcement authorities. Effective ROE training and battle drills will enable soldiers to respond immediately in various law enforcement situations.

LESSON: Develop ROE for individual soldiers that are clear, concise, simple, and unclassified, and that allow soldiers to implement them under stress without referring to a ROE pocket card. Develop and train OOTW battle drills to protect the force, especially in the areas of troop movement and security.

Real Property Maintenance Activities. Engineers play a critical role in developing the infrastructure needed for any OOTW mission. Engineers provide real property maintenance activities (RPMA) capabilities such as base camps for disaster relief operations and lodgement and expansion operations in austere theaters. To facilitate RPMA, commanders should identify a terrain manager before they deploy for a joint operation and use a joint facilities utilization board to resolve RPMA problems that develop on-site. For disaster relief operations, a joint coordination board composed of impacted federal, state and local governments and agencies as well as the public may be extremely useful. During Hurricane Iniki recovery operations, a board composed of interested parties determined priorities for allocating available electrical resources.

LESSON: Commanders must plan to provide real property maintenance activities in any OOTW mission. Use terrain managers and joint facilities boards to coordinate RPMA support with all concerned civilian and military agencies and groups.

Sanitation and Hazardous Waste Control. Sanitation and hazardous waste control will be a critical engineer mission during any OOTW. Commanders must ensure waste management capabilities are emplaced early in the deployment cycle. In Somalia, engineer units immediately needed Class IV construction materials and heavy earthmoving equipment to collect and dispose of human and solid wastes. Following Hurricane Andrew, engineer units found it difficult to properly identify, locate, and control all commercial assets such as portable toilets. Another problem arose when some contractors refused to service any portable toilets except their own. Procedures are also needed to direct the disposal of hazardous wastes, such as waste oil, PCPs (found in electric transformers), asbestos and medical wastes. Publicize these procedures as early as possible once operations begin.

LESSON: Be prepared to perform sanitation and hazardous waste disposal operations during OOTW to protect the environment while meeting mission requirements.

Operations

Communications. Communications are especially vital during OOTW missions because of the many diverse services, agencies, and personnel involved in them. Commanders should consider purchasing cellular phones and police-compatible radios for disaster relief missions. Coordinate communications equipment frequency requirements with local supporting forces and local agencies prior to deployment. Purchase or lease fax machines, copiers, and E-MAIL capability and provide them down to the task force level. Also consider deploying tactical satellite

(TACSAT) to enhance communications in austere environments.

LESSON: Deployed units must maintain effective communications with all personnel and agencies involved in the operation. It may be necessary to supplement military communications equipment with off-shelf, commercial communications equipment.

Contracting. Do not overlook the different contracting mechanisms available for OOTW missions. During Hurricane Andrew relief operations, the use of contracted civilian engineer equipment increased productivity and dramatically improved debris removal. Command and control of the contractors' equipment, however, became significant. In this operations, engineer company grade officers and noncommissioned officers were required to supervise contracted work. Prior to deployment, units should identify the names, locations and telephone numbers of authorized dealerships capable of providing contracted engineer parts and equipment in theater. Dealership parts manuals should also be acquired. To ensure timely contracted services are provided for follow-on forces, contracting officers should deploy with the advance party.

LESSON: Plan on contracting for civilian services and/or equipment. Be prepared to provide contracting officers.

Termination and Post-OOTW Operations

End State. "Determining the end state and ensuring that it accomplishes the national objectives are the critical first steps in the operational planning process. Failure to make this determination will waste scarce resources and put the entire effort at risk." (FM 100-5, Operations). While determining the end state is difficult during combat, it is more difficult during OOTW.

Commanders must focus their vision beyond the immediate OOTW objective and clearly articulate the conditions of success or the end state. For example, during the 1993 midwest flood-relief operations, the National Guard developed consensus by mutual agreement with local authorities to help determine an end state. A common technique was to tie the disengagement of National Guard forces to a measurable event such as river depth or opening of a bridge. Once an end state is identified, it is crucial that disengagement actions be fully announced and understood by all concerned parties. Where appropriate, establish disengagement criteria with the Federal Emergency Management Agency (FEMA) and state and local authorities.

LESSON: The importance of defining an end state and the requisite conditions for mission success cannot be overstated. Use quantifiable measures to define the end state. Whenever possible, gain consensus among all interested parties and ensure all parties are informed when the end state has been reached.

Redeployment, Reconstitution and Demobilization

Redeployment. Commanders must focus on many of the same requirements during the redeployment phase that they had to contend with during the deployment phase, including a plan for the orderly flow of personnel, equipment and supplies. This requirement became blatantly obvious after Hurricane Andrew, when an engineer brigade, an engineer group, two combat heavy engineer battalions and two engineer combat support equipment companies received redeployment orders within three days of each other. Their requirements overtaxed engineer line-haul capabilities and caused long delays in redeploying equipment.

An important consideration on redeployments from OCONUS is the need to perform customs inspections prior to redeployment. Extensive cleaning will be required before engineer equipment can be loaded on ships or planes. Commercial steam cleaners provide valuable assistance in this endeavor.

LESSON: Be prepared to support redeployment operations, while simultaneously redeploying yourself and your unit.

Your unit has just returned from a successful deployment. All personnel and equipment performed exactly as planned. The time spent reviewing the lessons learned from previous operations was well spent. As with any operation, however, the mission is not finished until the paperwork is done. You have incorporated lessons learned into your after-action report planning. Throughout the entire operation you ensured that observations and lessons learned were captured when they occurred, while they were fresh in everyone's mind. As a result, the after-action report was completed almost as soon as the last vehicle closed on the motor pool. After completing the report, you sent a copy to the Directorate of Evaluation and Standardization at Fort Leonard Wood, which serves as the Center for Engineer Lessons Learned for the U.S. Army Engineer School.

For more information write to: Commandant, U.S. Army Engineer School, ATTN: ATSE-ESA-L, Fort Leonard Wood, MO 65473-6630 or call (314) 563-4005 or DSN 676-4005.

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Integration of Engineer Groups in Support of a Light Division

By Lieutenant Colonel Peter Madsen and Major Wayne Whiteman

Future world trends indicate a more frequent and increased role for the military in humanitarian missions and disaster relief. Recent examples include protecting Kurds in Iraq, securing Haitians at Guantanamo Bay, cleaning up south Florida after Hurricane Andrew, and assisting in humanitarian efforts in Somalia. The 10th Mountain Division, Fort Drum, New York, was involved in the last three of these missions.

When faced with operations other than war, military leaders must go through a rapid mission-analysis process to determine the best force mixture to send. The decision in Florida and Somalia was to focus efforts around a light division's structure and tailor the forces that augmented the division to meet the specific needs at the moment. The strategic mobility, command and control structure, logistics support, and medical systems of the military lend themselves well to these types of missions.

Because engineers will always play a large role in humanitarian missions and disaster relief, their augmentation to the force is often significant. During Hurricane Andrew relief, the 10th Mountain and the 41st Engineer Battalion (light) were augmented by one engineer group, three engineer battalions, two combat support equipment companies, and one assault float bridge company (see chart). During Operation Restore Hope, the 10th Mountain's augmentation consisted of one engineer group, one combat heavy engineer battalion, and two combat support equipment companies.

The augmentation process can be complicated. This article addresses the integration of forces in support of a light division and the lessons learned from both of these operations.

Operational Integration

Engineer staffs in light divisions are austere. The assistant division engineer (ADE) section is authorized only four personnel by the modified table of organization and equipment (MTOE). The S3 section is authorized only seven personnel. The challenge is to form an engineer staff strong enough to direct significant engineer augmentation as an extension of the division G3. Within the 10th

Engineer Task Organization

Hurricane Andrew Relief—

Initial

- 41 Engr Bn (Light) (Drum)
  - 642 Engr Co (CSE) (Drum)
- 937 Engr Gp (Riley)
  - 43 Engr Bn (Cbt Hvy) (Benning)
    - 63 Engr Co (CSE) (Benning)
  - 841 Engr Bn (Corps Cbt) (USAR) (Florida)
  - 586 Engr Co (ARFB) (Benning)

Final

- 41 Engr Bn (Light) (Drum)
  - 642 Engr Co (CSE) (Drum)
- 92 Engr Bn (Cbt) (Hvy)

Operation Restore Hope—

- 41 Engr Bn (Light) (Drum)
- 36 Engr Gp (Benning)
  - 43 Engr Bn (Cbt Hvy) (Benning)
  - 63 Engr Co (CSE) (Benning)
  - 642 Engr Co (CSE) (Drum)

Mountain, the 41st combines the assets of the ADE, S3, S2, and the communications sections to form engineer operations and planning cells collocated at the division main command post (DMAIN). (See a related article in the July 1992 issue of *Engineer*, "Light Engineer Command and Control.")

The engineer operations cell is located in the division tactical operations center (DTOC). This cell works closely with the division G3 and tracks current engineer operations and missions throughout the division sector. Operational reports are sent through the engineer operations cell and forwarded to the division and the engineer sections of the next higher headquarters. Brigade engineers send reports directly to engineer operations for all engineer assets working in their brigade sector. When faced with significant engineer augmentation, as was the case in the Florida and Somalia missions, the reports of other engineer units in support of the division are rolled up under the engineer group, forwarded to engineer operations, and included in the situations reports to division and higher.

The engineer planning cell is located adjacent to the DTOC within the security perimeter of the DMAIN. This cell works closely with the division G3 plans section and the operational planning group. Future engineer plans and operations are developed as part of the command estimate process. If required, liaisons from the engineer group or other engineer units can operate from this location. The engineer plans cell also serves as a briefing/meeting area for the division engineer.

Two engineer soldiers clear debris during Hurricane Andrew relief operations in south Florida.

The Division Engineer

An age-old debate is who serves as the division engineer when an engineer group is attached to a light division. The group is commanded by a colonel; the divisional battalion commander is a lieutenant colonel. The dilemma is whether to interject a senior engineer commander and his field grade staff from outside the division or leave the organic engineer section integrated with the divisional staff under the direction of the divisional battalion commander. FM 5-71-100, *Division Engineer Combat Operations*, states that the group may become the engineer headquarters for a light division when the division receives significant engineer augmentation. In special cases, the division commander may transfer division organizational responsibilities to an engineer group that has been task organized to the division on a long-term basis. Normally this is done only when the augmentation surpasses the command and control capability of the light battalion headquarters. While many factors weigh in the final decision, two important factors are the length of unit integration and the expected duration of the operation.

In a crisis response such as hurricane relief, a premium is placed on how fast engineers start work on the battlefield. The division staff relies heavily on its training, teamwork, and personal chemistry to respond effectively to emergency situations. Substituting engineer staffs during a crisis response creates problems for the deploying group headquarters and can be disruptive to the time-sensitive division staff planning.

In short-duration operations, engineers are working against a timeline, and similar arguments are true. For example, during Operation Restore Hope, Army engineers were given a defined mission to accomplish in six weeks. Redefining roles would have been disruptive when time was a critical element. It made more sense to allow the group headquarters to focus its efforts on planning and executing the engineer operation and to permit the divisional engineer section to integrate this plan with the overall scheme of maneuver and identify future engineer requirements.

Engineer groups are flexible organizations designed to strengthen the command and control of subordinate units. As quickly as they respond to engineer requirements exceeding divisional capability, they can be withdrawn to support other sectors or commands. For example, during Hurricane Andrew relief, the 937th Engineer Group was attached to the 10th Mountain in early September but redeployed with the XVIII Airborne Corps in late September, leaving behind one combat heavy battalion.

The division commander decides who his principal engineer staff advisor will be. Regardless of his choice, the engineer group commander serves as a major subordinate commander for the division and has direct access to the CG. During Hurricane Andrew relief and Operation Restore Hope, the divisional engineer battalion commander retained staff responsibility as the division engineer. Both operations were a response to a crisis on an engineer intensive battlefield, and it made sense to leave the organic divisional engineer section in place.

Shaping the Engineer Force

Mission analysis identifies the engineer requirements that drive the force structure. Generally, the organic sapper battalion of a light division deploys with maneuver units and provides sustainment, force protection, and direct support. Augmentation engineer forces address other engineer requirements: road and airfield construction, basecamp support, utility repair, fire fighting, power generation, and more. The group staff has the capability in personnel and equipment to plan, design, manage, and support these extensive operations.

The relief operations for Hurricane Andrew and humanitarian assistance in Somalia were quite different tasks. In both operations, the mix of augmentation engineer forces and the task organization structure were tailored to meet specific requirements. For example, in Florida, the 586th Engineer Company (ribbon bridge) deployed trucks from Fort Benning without their bridge bays. These trucks hauled critical food distribution requirements and augmented the limited transportation assets of the 10th Mountain. Also, the 642d Engineer Company (combat support equipment) served as a brigade engineer headquarters in Florida and deployed only bucket loaders and dump trucks to clear debris. In contrast, during Operation Restore Hope, the entire 642d deployed and was attached to the 36th Engineer Group for road construction as part of the group's mission to revitalize Somalia's infrastructure. Force structure design and task organization of augmentation engineers are major tasks that must be addressed early in the planning cycle by the divisional engineer battalion command and staff.

Lessons Learned

The lessons learned by the 10th Mountain Division in Florida and Somalia will be applicable to future operations other than war. Analysis of each operation offer insights for future engineer planning and execution.

Reception Mission. Early reception of the engineer group into the division is critical. Key leaders and staffs must be integrated into the division's planning cycle. They should be briefed on the current situation and be familiar with the division planning and methodology. Division SOPs and report formats must be exchanged. The desired end result is division ownership of the engineer group as a major subordinate command in support of the operation.

Reception of the engineer group includes the arrival of their subordinate units, personnel and equipment in the area of operations.In most situations, the division is on the ground before the engineer group and other augmentation units arrive. The division battalion must facilitate this reception and serve as the coordinating headquarters for the smooth introduction of engineers into theater.

An assembly area or base of operations must be identified. An engineer base may require motor parks, tentage, field latrines, and a mess operation to support the arriving personnel while they await equipment. If equipment arrives into theater before the personnel, divisional engineers may need to receive it to avoid congestion at the railhead or port. (During Restore Hope, divisional engineers off-loaded the ship bearing group equipment and MILVANS when the personnel arrived later.) Depending on the size of the augmenting force, this can be a significant mission and can detract from other efforts.

Reception also includes activities such as the alignment of maintenance support and the opening of supply accounts within the division. The two most significant challenges are communications support and Class IX repair parts for commercial engineer equipment. These problems must be addressed before deployment to facilitate integration into the division and early execution of the engineer plan.

Selling the Engineer Plan. Mission analysis identifies the engineer requirements. The division engineer recommends the assignment of missions to subordinate engineer forces and the G3 tasks these missions to subordinate commands. Then the engineer group must develop its plan for execution. Often the division engineer may be involved in war gaming the courses of action, and may even be asked for a recommendation. Once the group commander selects the plan for execution, the division engineer must sell the engineer plan.

The first step in selling the plan is to get the support of the division commander. The division staff is then brought on line and the G3 integrates the engineer plan with maneuver operations. The G4 acquires necessary logistics support, and signal aligns necessary communications support while other staffs play their appropriate roles. The plan should then be layed out and briefed in detail for subordinate maneuver and support commanders.

Expanding support and awareness of the engineer plan will facilitate its execution. Besides briefs to key leaders, other methods worked well during Restore Hope and Hurricane Andrew. Brigade engineers from the divisional engineer battalion kept maneuver commanders informed on execution and progress. Daily staff meetings at division headquarters and periodic engineer meetings at the higher headquarters served similar purposes. Public affairs also assisted in selling the engineer plan, especially when the plan significantly impacted on the public or nongovernmental organizations.

Making the Plan Work. Brigade engineer efforts will dramatically influence the success of an engineer group in support of a division. By coordinating direct support in the brigade sector, they promote the mission of the brigade commander while allowing the group engineer the flexibility to shift engineer effort as priorities change.

The division engineer influences the engineer effort by grasping the engineer multipliers as they become available on the battlefield. For example, after Hurricane Andrew, volunteer assets from municipal public works departments throughout the southeast came into south Florida. With very little coordination but a lot of cooperation, they teamed up to haul debris in one brigade sector. This allowed the brigade engineer to free up critical haul assets for use in another sector.

When deployed overseas, tapping into the capabilities of the Corps of Engineers (primarily through contracting) or the DOD logistics capabilities contract can save troop effort and enhance success. In Somalia, engineers gained a unique experience working with civil affairs and psychological operations (PSYOPS) teams. Leaflet drops, print media, coordination meetings with local elders, and the hire of local laborers facilitated the engineer effort. In operations other than war, engineer multipliers are many, and the division engineer has the best vantage point to identify them.

End State and Mission Creep. An important part of the engineer plan is the end state. Engineer requirements in operations other than war often greatly exceed the forces or time available. Identifying standards for construction, repair, and troop support is key. The scope of work and proposed completion date are essential elements of the plan. The engineer end state should be synchronized with the maneuver plan.

A key factor in creating engineer success is avoiding mission creep. Every plan under execution will be challenged with new or expanded missions that may or may not have to be done. However, each new mission expends time and resources. The key is understanding the division commander's and the next higher commander's intents as they apply to the engineer effort. The division engineer can then make mission assessments, understand impacts, and advise the G3 on which missions to accept or decline. The engineer group should focus on executing the engineer plan; the division engineer staff should address mission creep.

Future Operations

The past several years have demonstrated that Army units can be very successful in operations other than war. In these situations, engineers are always a key player. During Hurricane Andrew relief operations and Operation Restore Hope, engineer groups played a key role in support of the 10th Mountain Division's efforts. The division engineer and engineer group relationship is critical to the quick integration of augmentation engineer forces and organization for execution. From the perspective of the division engineer, significant lessons were learned regarding the reception of the group and the development and promotion of the engineer plan. Early identification of the roles and responsibilities is critical. Given the professionalism and initiative of our leaders, coupled with trained and ready soldiers, engineers will always succeed.

Lieutenant Colonel Peter Madsen is the battalion commander for the 41st Engineer Battalion, 10th Mountain Division. Past assignments include tours with the 82nd Airborne Division, 7th Engineer Brigade, Germany; and the Missouri River Division, USACE. A graduate of the Command and General Staff College, he holds a masters degree in civil engineering from Georgia Tech.

Major Wayne Whiteman is currently studying for a doctorate in mechanical engineering at Georgia Tech. Previous assignments include S3 of the 41st Engineer Battalion, assistant professor at West Point; and company commander of the 2nd Engineer Battalion. Major Whiteman is a graduate of West Point and holds a masters degree from Massachusetts Institute of Technology.

Photo courtesy Javelin Joint Venture team

The Javelin:

Reach Out And Touch Someone

By Sergeant First Class Daniel Copson,
Sergeant First Class Richard Kelley and
Staff Sergeant Bret Harley

Combat readiness groups will launch into a new era in fiscal year 1996 when a new weapon system designed to kill tanks at ranges greater than 2000 meters is fielded. The system, called the Javelin, is a man-portable "fire and forget" antitank missile with a tandem-shaped charge warhead. Designed to defeat all types of armor, including reactive armor, it will be a welcome addition to the engineer squad's arsenal. The system consists of two components, the command launch unit and the round.

Components

The command launch unit (CLU) controls all aspects of Javelin operation. It houses all the controls, indicators, and sights the gunner will use during surveillance and target engagement procedures. The Javelin has three sights that the gunner can select at the push of a button. They include one day sight, which has a 4X magnification, and two imaging infrared (IIR) night sights, which have a wide field of view at 4X and narrow field of view at 9X magnification. The IIR night sights allow the gunner to see enemy tanks at extended ranges in adverse weather conditions and times of limited visibility. The CLU's IIR night sights also make it a useful reconnaissance and surveillance tool. It will give readiness groups the ability to reconnoiter an area or objective from an over-watch position in hours of darkness or poor visibility conditions.

The second component, the round, consists of the missile and the launch tube assembly (LTA). The missile has an automatically self-guided, passive IIR seeker to lock on a target before it is launched. It has a two-stage solid propulsion system. The first stage is the launch motor, which is designed to burn for only 1/10th of a second. It propels the missile away from the gunner before the flight motor fires, and reduces the initial back blast, heat, flames, and debris that the gunner is exposed to with other antitank weapon systems. The soft-launch design of the Javelin allows the gunner to safely fire from inside buildings or from covered fighting positions. The second stage is the flight motor. After the launch motor propels the missile about 15 meters away from the gunner, the flight motor ignites to carry the missile to the target.

SFC Copson tests a soldier on one of the 15 qualification exercises that can be used with the basic skill trainer (BST).

Operations

After the gunner has identified a target using the CLU, he can quickly attach it to the round and begin the engagement sequence. In the engagement sequence, the gunner views the target scene in the eyepiece, places the track gates over the selected target and locks the missile onto the target. Once locked on, the missile is ready to fire.

When firing, the gunner can pick between two attack modes: the top attack and direct attack. The top attack, the primary attack mode, is used to engage targets in the open at up 2000 meters. Using an arched trajectory, the Javelin climbs above its target for improved visibility and then strikes where the armor is weakest. The direct attack mode is used for targets within 1000 meters that have overhead cover, such as inside buildings or under bridges. The direct attack mode is also used for special targets such as helicopters, bunkers, and very short-range targets.

Training Devices

A key feature of the Javelin system is that two training devices, called the basic skill trainer (BST) and the field tactical trainer (FTT), come with the system.

The BST (shown above) is designed for classroom use. It consists of an instructor station and a simulated round attached to the CLU simulator. Computer-generated battlefield images are

A soldier tests the fully integrated, three-dimensional training (FTT) devise during a field exercise.

displayed in the CLU to teach basic target identification, acquisition, and lock-on skills to gunners. The instructor can select one of 31 scenarios and any of 15 qualification exercises. After each engagement, the instructor immediately scores and critiques the gunner's performance.

The FTT (shown above) is a fully integrated, three-dimensional training device that is designed to simulate the form, fit, and function of the real tactical Javelin system. It is configured either with or without the FTT instructor station. In either configuration, the FTT integrates the tactical CLU with a simulated round. The FTT allows the gunner to simulate war-fighting in a tactical environment (force-on-force). With the FTT instructor station installed, the instructor can tape the gunner's engagement sequence on an 8mm video tape. This tape is used for review and critique after the exercise. A backpack is provided to help transport the instructor's equipment during the training exercise.

The simulated round is incorporated as a subsystem for the Multiple Integrated Laser Engagement System (MILES); it is used for use during force-on-force engagements. The FTT MILES subsystem enhances the soldier's learning experience during the training exercise by allowing simulated engagements of targets and immediate feedback concerning the success or failure of the engagement. Even without the FTT instructor station installed to record the engagement on video tape, the gunner's engagement actions are recorded as MILES events. The FTT MILES Event Recorder stores up to 300 of the gunner's events for later review and critique.

Fielding

Select units are scheduled to begin receiving the Javelin during fiscal year 1996. Due to production delays, other units will not receive the Javelin until the year 2000 or later. Therefore, units must retain their 90mm

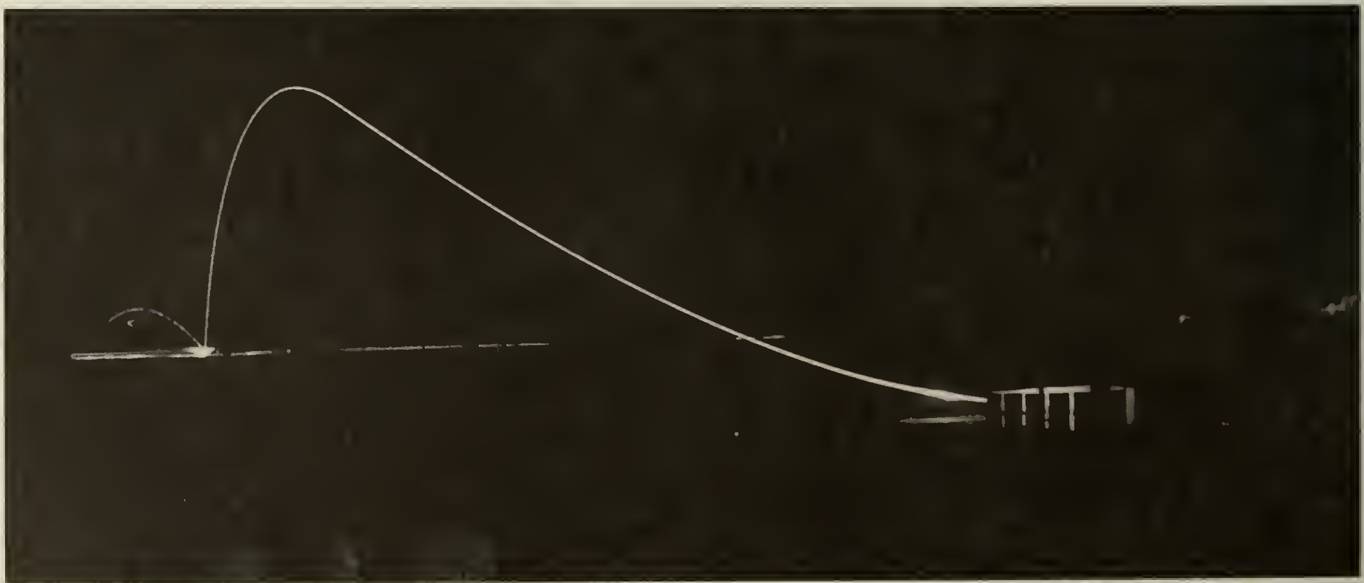


Photo courtesy Javelin Joint Venture team

This time-lapse night shot shows a Javelin missile being fired out of an enclosed building. The target is a T72 tank at approximately 500 meters.

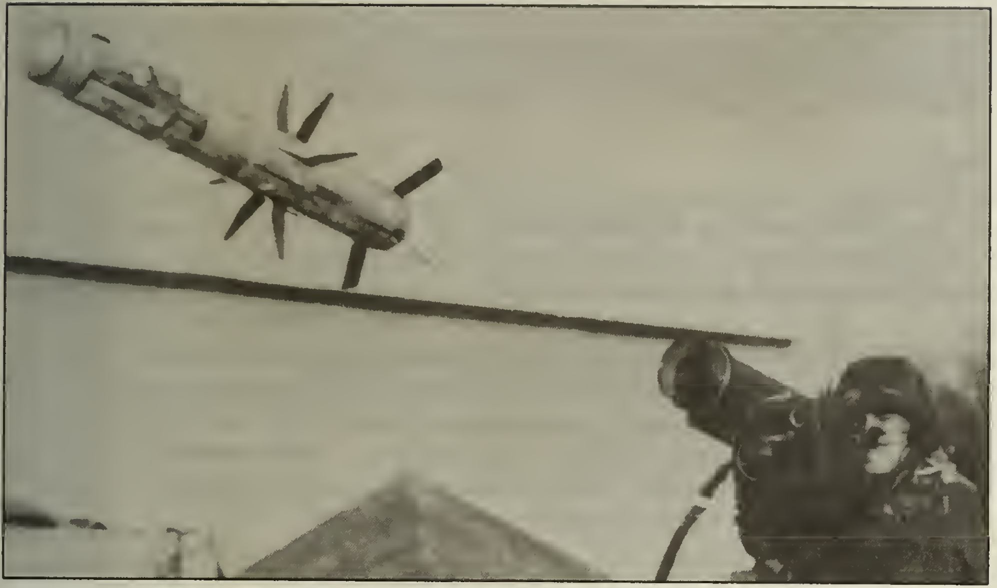

A soldier launches a missile from the Javelin launch tube.

Photo courtesy Javelin Joint Venture team

recoilless rifles until they receive the Javelin system for replacement.

The new Javelin system is designed to enhance the missile-launching skills of combat readiness groups. The high-tech characteristics and "fire and forget" capabilities of the Javelin will thrust these groups forward into the 21st century and improve mission readiness for troop deployments Army-wide.

Sergeant First Class Daniel Copson, a senior writer/instructor for the Department Tactics and Leadership at the U. S. Army Engineer School, has completed the Javelin subject-matter expert course. He previously served as a platoon sergeant with the 8th Infantry Division during Desert Storm. SFC Copson is a graduate of the Advance Non-Commissioned Officer Course (ANCOC) and holds an associate degree from Central Texas College.

Sergeant First Class Richard Kelley, a writer/instructor for the Department Tactics and Leadership at the U. S. Army Engineer School, has completed the Javelin subject matter expert course. He previously served as a platoon sergeant with the 1st Armor Division. SFC Kelley is a graduate of the ANCOC.

Staff Sergeant Bret Harley, a writer/instructor for the Department of Combat Engineering at U. S. Army Engineer School, has completed the Javelin subject-matter expert course. He previously served with the 54th Engineer Battalion during Desert Storm and is a graduate of the Basic Non-Commission Officer Course.

(Personal Viewpoint, continued)

helipad construction, communication tower construction, building demolition, and firing range construction. A conscious effort is made to match unit capabilities with mission requirements. Unit commanders working for JTF-6 have documented training on at least 85 percent of their METL tasks in their post deployment after-action reports.

During FY 93, engineer units repaired or constructed 362 miles of road (with accompanying culvert, fords and drainage), seven firing ranges, two helipads, and more than 14 miles of border fence. Other missions included power line relocation, fitness course and rappel tower construction, a drug-dog kennel, and structural demolitions.

Units also receive hands-on training in the requirements of environmental law. Units operate under strict environmental constraints. To ensure compliance with laws and regulations, JTF-6 provides qualified environmental surveyors and monitors to constructing engineer units. Commanders plan and execute environmentally sound projects, and troops become familiar with environmental procedures and protection.

Join Us!

There is a vital mission for engineers on the southwest border, one that directly supports our national security. Training opportunities abound for engineer units that are aggressive and innovative. We must convince installation commanders and ourselves that counterdrug operations are a valid, vital military mission. They offer great opportunities to support law enforcement, provide service to the American people, and conduct realistic training in a rugged environment, against a real threat.

Each quarter, the JTF-6 engineer branch publishes an electronic message addressed to corps, divisions, engineer brigades and groups, and individual units announcing missions available along the border. For information about engineer missions, call me or Major Brian Hearnsberger at (915) 568-8209/8733 (DSN 978). Join us for some great engineer training!

Lieutenant Colonel DeHarde is the staff engineer for Joint Task Force Six, Fort Bliss, Texas. Previous assignments include instructor at the U.S. Army Command and General Staff College, battalion executive officer, USAREUR Engineer Plans officer, deputy resident engineer/operations officer in Riyadh, Saudi Arabia, and company commander. LTC DeHarde holds a masters degree in civil engineering from Texas A&M University.

Engineer Problem

Estimating Gap Width

Measuring the width of a wide river or other gap without access to the opposite shore requires ingenuity and the use of some fundamental trigonometry to accomplish the mission. Field Manual 5-34 (page 5-16) provides an easy, straightforward method of estimating the width of a river that works in most cases. Sometimes, however, the shape of a river channel, obstructions, or the tactical situation may preclude using this method.

An alternative method is described in the Soviet manual *Combat Engineer Support*, by Y. Kolibernov. This method uses two measurements, one at the river bank and another several meters back from the bank. Advantages to this method are that it exposes the estimator less to enemy observers, and it may be accomplished wherever two landmarks on the opposite bank can be seen. A disadvantage is that this method is subject to greater error than the one described in FM 5-34. For combat engineers, Kolibernov's method may be a useful alternative when the FM-34 method is impractical.

Method

At the gap's edge, locate a landmark directly across the gap. Choose another landmark several meters away and measure the angle between them with a compass or binocular scale. (This is the angle "η_1" in the figure on page 35). Step back from the bank a known distance (the distance "B" on the figure) and measure the angle between the same landmarks at the new observation point. (This is the angle "η_2"). The width of the gap, W, now may be approximated using the expression:

$$W = B\frac{\eta_2}{(\eta_1 - \eta_2)}$$

The angles may be measured using any device because the formula is independent of units used. For those interested, the derivation of the expression follows:

Imagine that the lines of observation in this problem form two triangles on the ground, as shown in the figure. If you chose the landmarks correctly on the opposite shore, the angle between L and W is a right angle. Therefore, the smaller triangle, from the Law of Sines is:

$$\frac{L}{\sin \eta_1} = \frac{W}{\sin \alpha_1} = \frac{W}{\sin (90 - \eta_1)}$$

Similarly, for the larger triangle:

$$\frac{L}{\sin \eta_1} = \frac{W + B}{\sin \alpha_2} = \frac{W + B}{\sin (90 - \eta_2)}$$

Now, the length "L" is identical in both triangles, and you can multiply each expression by the sine terms under the L and equate the results:

$$L = W\frac{\sin \eta_1}{\sin (90 - \eta_1)} = (W + B)\frac{\sin \eta_2}{\sin (90 - \eta_2)}$$

Note that for any angle, sin (90-a) = cos a. You can substitute the cosine for the denominators above:

$$L = W\frac{\sin \eta_1}{\cos \eta_1} = (W + B)\frac{\sin \eta_2}{\cos \eta_2}$$

Since $\frac{\sin a}{\cos a}$ = tan a for any angle,

$$L = W \tan \eta_1 = (W + B) \tan \eta_2$$

Engineer Problem

$$L = W \tan \eta_1 = W \tan \eta_2 + B \tan \eta_2$$

Gathering terms involving the W to the left side,

$$W(\tan \eta_1 - \tan \eta_2) = B \tan \eta_2$$

and, therefore:

$$W = B \frac{\tan \eta_2}{(\tan \eta_1 - \tan \eta_2)}$$ (This equation is the exact expression.)

However, if both angles η_1 and η_2 are less than 30 degrees, a good approximation of the distance W may be made by the expression:

$$W = B \frac{\eta_2}{(\eta_1 - \eta_2)}$$

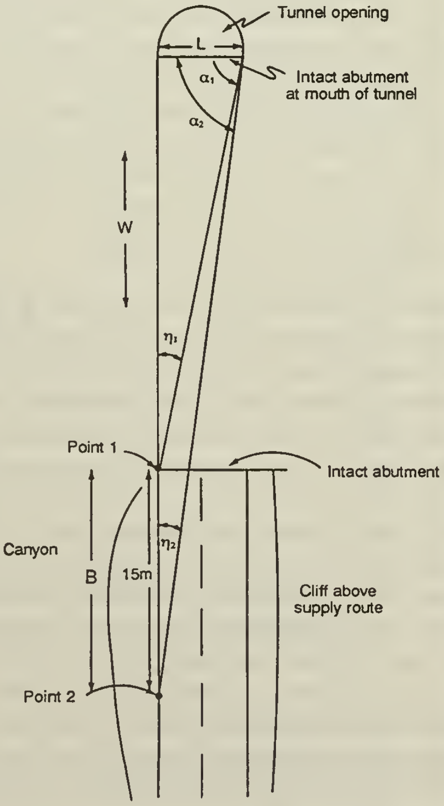
Note that the expression is independent of the units involved.

Problem

Recent faction activity in part of Bosnia-Herzegovina has rendered a main supply route impassible due to a destroyed bridge over the mouth of a canyon. The route is cut along the side of a gorge, and the destroyed bridge spanned a tributary of a larger river. Traffic must be restored quickly so humanitarian aid convoys can resume. The UN Protective Force (UNPROFOR) has several sets of Bailey bridge available for route repair.

Your mission is to determine the width of the gap the Bailey bridge must cross. A major difficulty is that you have access only to the near shore because of the nature of the gap and because uncooperative factions control the surrounding territory where all bypasses are located. The road is cut along the side of the gorge and cliffs to the right and left of the route deny access along the tributary. Therefore, it is not possible to determine the gap width using the method described in FM 5-34. On the near side, the road is reinforced concrete and the abutment of the bridge is intact. On the far shore, the abutement is intact and the road enters a tunnel of unknown width.

Standing at the near edge of the gap and measuring the angle between the two sides of the tunnel opening, you find the angle is 14 degrees. Moving away from the gap on a straight line for a distance of 15 meters, you again measure the angle between the same landmarks; this angle is 9 degrees. Using only this information and the standard design criteria for a Bailey bridge, determine the design length for the bridge.



Reference: FM 5-34.

ENGINEER Solution is on page 42.

Leadership Without Speed Bumps

Changing Times

It was so easy in the good old days. We had the forces and we were focused. We could see, touch and even smell the "enemy." Our Army was combat ready and leaning forward to the sights of a Berlin Wall, red star, and hammer and sickle, even to the whiff of smoke from a Havana cigar. But, times have changed.

The international road signs of evil are gone. It appears that the United States no longer needs a large standing Army. As other priorities demand our nation's dollars and attention, the reductions in military resources quickly translate to a "do more with less" mentality where the ultimate "less" is leadership time. Our "flash to bang" on mission execution has just been tightened. But the enemy is not gone, it has only changed its shape. What is gone is TIME.

Our nation expects Army engineers to accomplish the unknown without any "on your mark, get ready" preparatory signals. Time to get ready and focus perspectives is gone. The past leadership era where leaders could pace themselves has vanished. Simply stated, they have taken away the "speed bumps" but not the hills and curves. We are in a leadership warp drive.

Our old Army had great speed bumps built in that provided blocks of time for us to get ready. The large size and redundancies provided time. Being able to track and predict international trouble spots allowed us to shape our responses in a timely manner. We had the luxury of being able to delay decision making until more information was available and more options were developed. Now we find ourselves moving at accelerated speed past discarded time regulators and protectors to undefined decision points.

While time has been drastically cut, readiness missions remain. There will never be another six months of prep time while the enemy watches. "Come as you are" roll-outs are here with all of their inherent dangers. It's as though the fire station has been moved to another county but folks still expect the firemen to make it in time to put out the fire. The issue for engineer leaders is how to make up for that lost time. We need to somehow create more time so that we can continue to perform within that expected band of excellence.

Finding Time

There are six ways to do it. Each one involves the understanding that time is most critical during final decision making. If that period is used for preliminary, time-consuming activities, then everything will stack up in a gridlock within that "do or die" time element. We need to protect the 11th hour. In other words, planning ahead is more critical than ever before. You may think the problem is that you don't have time today to read on, but a more accurate statement is that you don't have time not to read on. To assure having future time, you must invest some now. The following training objectives will help you recapture control and regain that needed time.

Soldier Care. How often have we found ourselves in the last throes of a roll-out when a "Why didn't I know this before?" crisis hits us? Crises range from "I didn't think I needed the power of attorney" to the more complex "His 17 year-old wife speaks no English." No matter what the issue is, it will consume time. As a leader, you will face crises involving your soldiers and their families. You have two choices: You can wait until the crisis to learn about your soldiers, and in so doing, consume critical decision and action time; or you can do that essential soldier caring now. The latter choice will protect time during the critical period where it is needed most. In essence, caring leadership done today will provide time to be banked, with time dividends available for future use.

By Colonel Herb Harback

Fitness. The thought, " Given enough time I could be in better shape," goes through my mind near the end of every PT test. Those push-ups, situps, and runs are only part of the total fitness required for mission success. Total soldier fitness encompasses mental, moral, and professional skills as well as physical readiness. There will never be enough time to get up to speed when we are playing the catch-up game. If your soldiers are not physically fit; are not clear in their sense of fairness, direction and values; or are not competent in their skills, knowledge and abilities when a crises occurs, you will be tasked with trying to turn everything around at the last minute. The old Fram oil filter commercial is an accurate metaphor: "Pay for me now at the low price of an oil change, or pay for me later at the devastating price of a new engine." The right time to be in physical, mental, moral and professional shape is now, not later.

Standards. If you don't know the rules of the game, it is hard to win. You would never send a team to participate in a game until they knew the plays, rules and "what if" drills. While we know it is hard to bone up while on the move, we often try to do it. Now is the time to engrain the standards of discipline, safety, and performance. These standards define the boundaries and set the azimuth. They must be communicated, understood and followed. Standards may be met in the last seconds, but they will consume all available time and result in ultimate mission failure. Standards provide the common language and direction for battle drills and SOPs; they allow us to call more "audibles" and be flexible to last-minute changes.

Battle Focus. We are our own worst enemy when it comes to battle-focused training. Too often we view training as being "real" only when done in a major training environment, and garrison training is often seen as a training distractor. We tend to take a "National Training Center or nothing" approach. We do our soldiers a disservice by assuming that mind-set. We also set ourselves up for unnecessary work when we assume a "go administrative" mind-set for garrison training and a "lets get serious" set of rules for the field. A recent example drives that point home. During this past winter's formidable storms, many engineer battalions were tasked by their garrison to help support snow removal. Units were tasked with heavy equipment demands and round-the-clock operations. The question is, did they approach the situation in a battle-focused manner with TOCs and appropriate FSOPs, or did the soft-cap shuffle take control? I'll bet that many heavy equipment operators were sent out to remove snow without basic combat equipment. Although they worked hard, they learned bad habits while plowing snow-packed streets. Just think how much time those units could have banked for the future if they had used that training opportunity for productive training.

Teamwork. Another way to provide more time is to be organized now. It may sound simple, but we generally come up short on this. When we get the next quick-reaction mission, let's see how much time we devote to team building and getting the team together. If we would build and sustain our teams now, much prime time would be freed up for the "stand in the door," critical decision making which always comes. Prearranged teamwork is what our units need to be able to call those critical, on-the-line "audibles." The time to work on team togetherness and fine-tune the synergism is before the kickoff not after it. Even the best football teams do practice drills before the game.

Attitude. Finally, there is the issue of attitude. It defines the team's vitality and high performance capabilities. A bad attitude sets our aiming sticks too narrow and places our marks too low. The ruts in the road begin to look like the horizon. To change that takes a lot of dedication and energy. Developing a winning attitude involves commitment and trust. Neither can be accomplished with "shake and bake" traits nor with a "quick fix" mentality. A positive attitude takes time and attention. It will be nearly impossible to establish when we are in the starting gate. If we develop a positive attitude now, we will have more time during the decision/action period.

High Speed-Low Drag

Our Army's vision states that there will be no time-outs for readiness. This article provides a simple solution to our accelerated pace and loss of leadership time. I'm talking about a strategic and think-ahead mind-set. Doing things concurrently, knowing our soldiers, developing a relationship with each one, and keeping them fit in body, mind, soul and abilities will establish standards based on our Army's vision. It will also provide our soldiers with clear mission essential task lists that are combat focused, founded on teamwork, and driven by a truly positive warrior spirit.

Colonel Harback is the commander and district engineer of the Louisville District, Corps of Engineers. He previously served as commander of the 14th Combat Engineer Battalion (Corps), Fort Ord. Other command and staff positions included executive officer, Bayonet Combat Support Brigade, 7th Infantry Division (Light); and deputy commander, 7th Engineer Brigade, VII Corps. COL Harback is a graduate of the Army War College.

Unit History: A Two-Edged Sword

By Dr. Larry Roberts

Quite often, young officers have walked into the History Office at the Engineer Center with the mission of writing a history of their unit. Usually, the task was given to them by a battalion commander, who wanted something for new soldiers to read. The obvious purpose of such a document is to instill a sense of pride in the unit, fostering unit morale and esprit. This is the traditional view of unit history. It is the reason units are allowed to maintain an organizational history file within the Modern Army Recordkeeping System (MARKS). However, that file, and unit history in general, can actually serve the unit commander in two ways. It can enhance unit morale/esprit and provide information for command decision making. This is possible only if there is command emphasis.

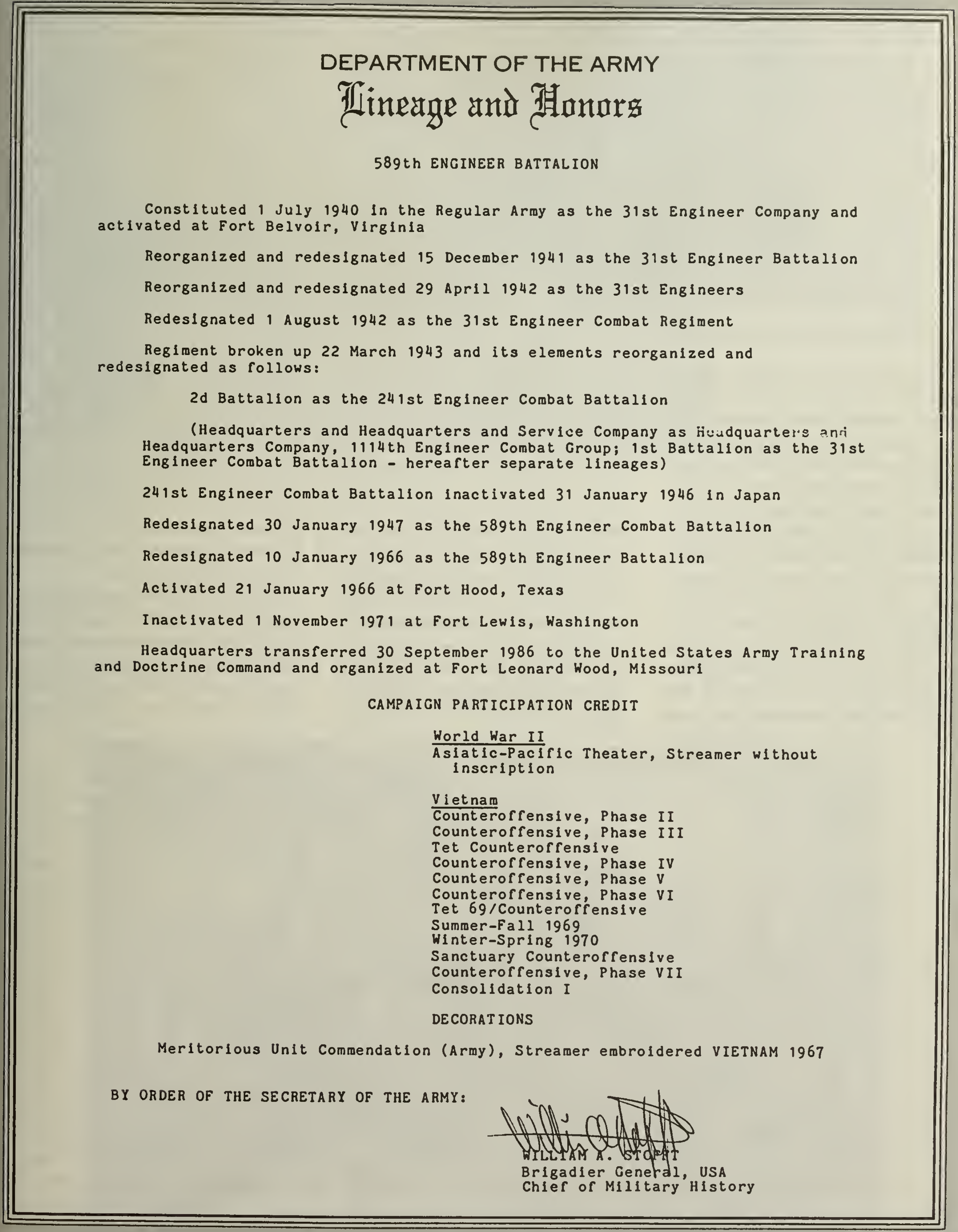
Few of those young officers who entered my office knew of a unit history file. Once informed of its possible existence, they went to it and often found little of value to their task. Unit history files run the gamut from little or nothing, save last year's annual history report, to a collection of random newspaper clippings, change of command brochures, and pictures of changes of command and organizational day activities.

While these items have merit, they do not completely document the unit's accomplishments in war or peace. Invariably, those officers returned to my office in search of more information. They ultimately learned that gathering material on their units is a slow process that involves working with a number of federal organizations. However, with patience and determination, they can get what they need.

Before contacting federal organizations for information, the unit historian should examine the unit's Lineage and Honors (see page 39), often found in the commander's office. This will save a lot of time. The Lineage and Honors details the unit's federal service and identifies the various campaigns for which the organization has service credit. By knowing the periods of federal service, the action officer can disregard those conflicts during which the unit was inactive. The Lineage and Honors will also identify parent organizations. Their files and histories are logically a part of the heritage of the unit and should be examined as well. The campaign credits will tell the researcher where the unit served. Campaign credits for the Pacific in World War II mean that the officer can ignore the European theater when doing work in published historical works. After reviewing the Lineage and Honors, the action officer can begin contacting other organizations for additional information.

There are a number of sources of unit history. The National Archives contains unit files for hundreds of organizations, especially for the years of World War I, World War II, Korea, and Vietnam. The major liability of the Archives is the cost charged to reproduce those files. If a unit chooses to purchase complete files, it normally finds copies of material, such as unit orders and correspondence, which have little merit for a written history. However, scanning the files to sort out the unwanted material requires a trip to the Archives, something few units can afford. One of the best approaches is to contact friends or associates in the Washington area and ask them to spend a couple of hours in the Archives.

Other information can be found in written histories, such as the official history of World War II, published by the Center of Military History, or books written by participants. Some material can be found in publications such as



DEPARTMENT OF THE ARMY

Lineage and Honors

589th ENGINEER BATTALION

Constituted 1 July 1940 in the Regular Army as the 31st Engineer Company and activated at Fort Belvoir, Virginia

Reorganized and redesignated 15 December 1941 as the 31st Engineer Battalion

Reorganized and redesignated 29 April 1942 as the 31st Engineers

Redesignated 1 August 1942 as the 31st Engineer Combat Regiment

Regiment broken up 22 March 1943 and its elements reorganized and redesignated as follows:

2d Battalion as the 241st Engineer Combat Battalion

(Headquarters and Headquarters and Service Company as Headquarters and Headquarters Company, 1114th Engineer Combat Group; 1st Battalion as the 31st Engineer Combat Battalion - hereafter separate lineages)

241st Engineer Combat Battalion inactivated 31 January 1946 in Japan

Redesignated 30 January 1947 as the 589th Engineer Combat Battalion

Redesignated 10 January 1966 as the 589th Engineer Battalion

Activated 21 January 1966 at Fort Hood, Texas

Inactivated 1 November 1971 at Fort Lewis, Washington

Headquarters transferred 30 September 1986 to the United States Army Training and Doctrine Command and organized at Fort Leonard Wood, Missouri

CAMPAIGN PARTICIPATION CREDIT

World War II
Asiatic-Pacific Theater, Streamer without inscription

Vietnam
Counteroffensive, Phase II
Counteroffensive, Phase III
Tet Counteroffensive
Counteroffensive, Phase IV
Counteroffensive, Phase V
Counteroffensive, Phase VI
Tet 69/Counteroffensive
Summer-Fall 1969
Winter-Spring 1970
Sanctuary Counteroffensive
Counteroffensive, Phase VII
Consolidation I

DECORATIONS

Meritorious Unit Commendation (Army), Streamer embroidered VIETNAM 1967

BY ORDER OF THE SECRETARY OF THE ARMY:

WILLIAM A. STOFFT
Brigadier General, USA
Chief of Military History

Unit crest of the 589th Engineer Battalion.

Stars and Stripes and *Yank* magazines. Command newsletters, such as the *Castle Courier*, the newsletter of the Engineer Command in Vietnam, are excellent sources for those units who served in Southeast Asia. Often, the Military History Institute at Carlisle Barracks is the best single source for much of this type of publication. The *Military Engineer* and *Engineer* magazines have traditionally published articles on unit activities. The Defense Technical Information Center (DTIC) has some of the quarterly reports (lessons learned) written by engineer units in Vietnam. Many Army libraries have access to DTIC and can order these reports.

The History Office, Office of the Chief of Engineers, at Alexandria, Virginia has an extensive unit history collection. A master index for each unit identifies what type of material is present, including oral interviews with senior engineer officers. In addition, a call or note to the Organizational History Branch, Center of Military History, Washington, D.C., can produce information on the unit's history and the symbology of the organization's crest (Distinctive Unit Insignia- DUI).

While the Engineer Center at Fort Leonard Wood has been slowly collecting unit material, there is much we do not have. A call or note would determine what is available. Again, with patience and determination, a young action officer can collect enough material to write a unit's history that is useful in telling the new soldier a story of challenges and accomplishments.

That story normally deals with operations in war. This is because most of the information found in the Archives, Carlisle Barracks, and other places deals with units in war. While that is important, combat constitutes only a small part of any unit's overall history. A greater amount of time is spent in peacetime and involves the countless challenges and requirements of an Army not at war.

Ironically, the unit's efforts in peacetime, in such areas as training, can provide the second important benefit of unit history and the organizational history file, support for decision making. A unit

Photo from the Brady Collection of Civil War photographs.

This historical photo of the 8th New York State Militia is an example of recording unit history.

This photograph, taken by CPT Dunham of the 43rd Engineer Battalion, Fort Benning, Georgia shows humor in recording his unit's history.

commander faces numerous challenges over the course of his or her command. Requirements for maintenance, training, post support, and family support compete for attention and resources. This is not new. Peacetime is traditionally the most demanding period for an army because resources are scarce and requirements are not. The knowledge of how one's predecessors handled these conflicting demands would benefit any commander.

For example, if after-action reports from unit field training exercises, to include the National Training Center, were maintained over time, the current command could identify areas of consistent strength or weakness. When coupled with completion reports of construction projects, post support detail summaries, etc., a new commander would know quickly what challenges he or she might expect. Copies of annual organizational inspections, especially in the areas of maintenance, would reveal the impact of these demands on the readiness of equipment, unit morale, and soldier support.

Many of these reports are found in other files in the headquarters, such as the S3 and S4 files. However, these items normally have a comparatively short file life. Regulatory requirements to retire certain files after a cutoff date and the simple need for file space normally account for the demise of historically-significant documents. By contrast, the Organizational History File, 870-5s, is a permanent file. Regardless of who maintains the file, it exists as long as the unit does. Therefore, material placed in that file will always be available to the commander or his/her staff.

Some may consider it strange to put a command inspection report or a field exercise after-action report in a "history" file. That is because too many believe that history is what happened 20 or 30 years ago. In fact, yesterday is history; it has happened and cannot be changed. The material placed in the historical file today becomes the historical material for all who will serve in the unit. Invariably, the value of that file is driven by the quality of material placed in it.

One of the most important items which could be placed in the file is a commander's review and assessment of activities. Virtually every unit is required to produce some form of annual historical report. Often, these documents are of marginal value being only copies of last year's input with the names, statistics, and dates changed. However, this report could be valuable if seen in the context of what was done, why, how, and the lessons learned from the effort. An annual, or even more frequent, summary of what the unit did, what initiatives were taken, what worked/what did not would be extremely useful to future unit leaders.

In times past, end-of-tour reports were common for many unit commanders and key personnel. Today, we tend to limit that type of report to general officers. However, there is no reason why key officers and NCOs in a command should not write such a report. It would not only be valuable in the unit history effort, but would also be useful in providing perspectives and insights gained during service with the unit.

History is valuable to the profession of arms. Many famous leaders have attested to the value of applying the lessons of the past to the challenges of the present. The knowledge and appreciation of a unit's accomplishments are important in building and sustaining esprit. Soldiers are challenged to maintain the traditions and standards of those who came before them. However, the raw materials of a unit history, the reports and papers that document what happened and why, can also be used to help current leaders guide their soldiers through the demands of today. Maintaining a viable file will also serve those who will follow.

Dr. Roberts is the historian for the Engineer Center, Fort Leonard Wood, MO.

Engineer Solution

Solution

Complete the following steps to determine the required length for the Bailey bridge.

1. Using Kolibernov's approximation, determine the width of the gap:

$$Gap\ W = B\frac{\eta_2}{(\eta_1 - \eta_2)}$$

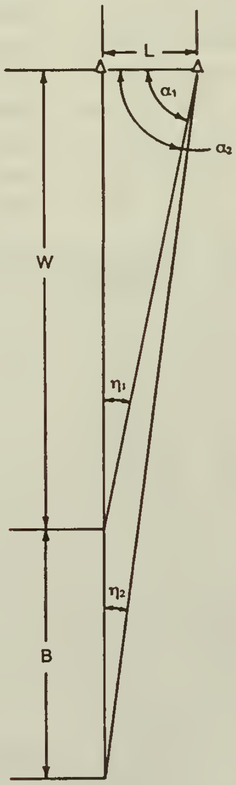
$$Gap\ W = 15m\frac{9}{(14 - 9)} = 27m = 88.6\ feet$$

2. Determine the safety setback for a Bailey bridge on prepared abutments (FM 5-34, p. 7-52).

SS = 3.5 feet (on each side).

3. Design gap = true gap + safety setbacks = 88.6 + 3.5 + 3.5 = 95.6 feet.

4. Rounding up to the next higher increment of 10 yields a required Bailey bridge length of 100 feet.



Note: Using the exact form of Kolibernov's formula, you should have obtained a gap width of 25.2 meters (82.68 feet), which yields the same bridge design. Note that the formula is very sensitive to error in the angle measurement. Therefore, you must measure carefully and verify the gap measurement as soon as you can reach the far shore.

This ENGINEER Problem/Solution was submitted by LTC William Bayles, executive officer, Old Ironsides Engineer Brigade, Bad Kreuznach, Germany. LTC Bayles has previously served as engineer brigade S3, battalion executive officer, and assistant professor of mathematics, U.S. Military Academy. A graduate of the School of Advanced Military Studies, he is a registered Professional Engineer in New Hampshire.

Engineer Force Structure:

Past, Present, and Future

By Peter Malley

Many articles have been published in recent months about changing the Army's strategy to account for a post cold-war threat and downsizing of the Army's force structure to meet that new threat. Most information written on this subject was taken from a "bottom-up review" study ordered by the Secretary of Defense, Les Aspin. The bottom-up study was a comprehensive examination of defense strategy, force structure, modernization programs, industrial base, and infrastructure in light of the new world situation.

This article is not an overview of the bottom-up review or of other articles on force structure. Instead, it explains what the Army engineer force was during the cold war, in the transition period from the old to the new strategy, and what the structure may look like as we enter the 21st century. It begins by defining the defense strategy and explaining how the force structure is developed through a process called "Total Army Analysis."

Changing Defense Strategy

Prior to the collapse of the Soviet Union, the United States' defense strategy was defensive in nature; it was primarily designed to hold the Soviet Union and China in check. The new strategy, as outlined in the bottom-up review, identifies four "dangers" to our national interests:

- Nuclear weapons and other weapons of destruction, including dangers associated with the proliferation of nuclear, biological, and chemical weapons.
- Aggression by hostile regional powers.
- The potential failure of democratic reform in the former Soviet Union, Eastern Europe, and elsewhere.
- Economic dangers to national security, which could result if we fail to build a competitive and growing economy.[1]

Building Force Structure

Senior Army leadership uses a process known as "Total Army Analysis" (TAA) to determine the force structure requirements to meet the threat. The process develops, for each program objective memorandum (POM) year, a projected program force that will meet mission requirements within anticipated resource levels.

TAA—What It Is and How It Works

Total Army Analysis is a complex, multiphased force structuring process. It consists of both qualitative and quantitative analyses that generate the tactical-support forces and general-purpose forces needed to sustain and support division and nondivision combat forces designated in the "objective force."[2] The objective force is the desired force in terms of force structure, readiness, modernization, and sustainability; it is constrained by expected fiscal and manpower levels. The Secretary of the Army (SA) and Chief of Staff of the Army (CSA) use the objective force when they provide guidance to the Army staff and major Army commands (MACOMs) for program development.

The Army conducts an analysis of force alternatives to determine the best force mix. Decisions on the objectives reviewed by the SA/CSA are then reflected in the The Army Plan (TAP).

TAA is a biennial process that is conducted during even-numbered years. It is followed by a Force Integration Analysis (FIA) that is conducted during odd-numbered years. Senior leadership is considering whether to change from the biennial to an annual process and possibly deleting the FIA portion; their decision will be made during TAA 2003.

The continuum and combination of the TAA and FIA are the basis for the Army's POM development and establishment of the program force, known as the "M-Force." The M-Force is based on the objective force and is neither fully structured, fully modernized, nor fully supported. It is responsive to operating strength deviation (OSD) sizing and structuring scenarios and is resource-constrained based on the OSD projections. The M-Force is

Engineer Force Structure
Personnel Losses

	TAA 96	TAA 99	TAA 01
Active	40,025	24,004	22,043
National Guard	57,245	39,105	37,138
US Army Reserve	32,663	22,005	21,729
Component 4 (Unresourced)	10,704	5,724	1,339
TOTAL	140,637	90,838	82,249

Table 1

projected from two to six years and has a higher degree of risk than the objective force.[3]

The TAA is a four-phased process that consists of force guidance, quantitative and qualitative analyses, and leadership review. The process evolves as follows:

Phase 1 (Force Guidance). Force guidance consists of input and guidance from various sources. The Defense Planning Guidance and The Army Plan provide the national strategy, threat data, resource assumptions and priorities. Force structure guidance is obtained from the TAP objective force. DOD-directed scenarios are specified in the form of illustrative planning scenarios. Additionally, the Army Force Planning Data and Assumptions (AFPDA) manual provides planning factors for theater-level studies and modeling by the U.S. Army Concepts Analysis Agency (CAA). For example, the number of engineer battalions (combat heavy) required in the force structure is based on information provided in the AFPDA manual.

A critical step in Phase 1 is the review and update of allocation rules used by CAA in Phase II. An allocation rule is the statement of a unit's capability, mission, and/or doctrinal employment. Put another way, doctrine justifies force structure and allocation rules translate that doctrine. Engineers have 281 allocation rules, which are updated during the Force Structure Conference I. This conference culminates when the General Officer Steering Committee (GOSC I) approves the rules and forwards them to the Concepts Analysis Agency (CAA) for implementation in Phase II.

Phase II (Quantitative Analysis). The quantitative analysis process takes the major combat forces (divisions, separate brigades, armored cavalry regiments, and special operations units) identified in the Army's objective force and determines the necessary tactical support requirements. The CAA accomplishes this analysis through a series of computer models and simulations. Through a series of reports, CAA then compares the new doctrinal support requirements with a current list of on-hand and programmed units to provide the "delta" for future programming. The TAA decision force is then disseminated to the MACOMs for review. As the last step in Phase II, the MACOMS and the Engineer School formulate issues to be analyzed during Phase III.

Phase III (Qualitative Analysis). During the qualitative phase, the initial program force is developed within end-strength guidance and then is used to develop the POM.

The second major conference, Force Structure Conference II (FSC II), is held during this phase. At this conference, senior leaders develop a force requirement structure through a series of analyses and panel reviews. They consider and validate the computer-generated requirements and review MACOM and HQDA inputs, proposed changes, and issues that center on claimants versus billpayers and prioritization. While the doctrinal basis of allocation rules were reviewed in FSC I, FSC II centers on the review of each discrete level and type of TOE unit in the decision force and the integration of TDA issues. Issues raised during the FSC II are resolved during GOSC II. The proposed force requirements are then forwarded to the Army's senior leadership for review and approval.

Phase IV (Leadership Review). The leadership review is initiated after the GOSC II meets to resolve any outstanding issues from FSC II. The Vice Chief of Staff of the Army chairs a force program review to resolve any issues from GOSC II; results are then briefed to the Army Chief of Staff for decision. The resulting force, the TAA base force, represents the force structure for POM development. It captures all components (active and reserve) and TDA requirements through the end of the POM years.[4]

Determining the Engineer Structure

Since 1988, the Army has conducted three TAAs; they developed the program forces for 1996, 1999, and 2001. As mentioned earlier, the program force is projected two to six years; thus, the program force 2001 in reality will be the force structure for fiscal year (FY) 1995. The programmed engineer force structure has dropped from 140,637 spaces in TAA 96 to 90,838 spaces in TAA 99, and to 82,249 spaces in TAA 01. Table 1 identifies, by component, the number of engineer spaces lost in each TAA. As of 1995, 72 percent of the engineer force structure will be in the Reserve Components.

Total Army Analysis Planning Scenarios

Total Army Analysis 1996 - 28 Division Force
Europe + Southwest Asia + Northeast Asia = Total Force

Total Army Analysis 1999 - 20 Division Force
Major Regional Contingency-East + Major Regional Contingency-West or Europe = Total Force

Total Army Analysis 2001 - 20 Division Force
Major Regional Contingency-East + Major Regional Contingency-West + Forward Deployed Europe + Unique = Total Force

Figure 1

Engineer Structure Losses

The following discussion, with Figure 1 and Table 2, page 46, outline the type of scenarios, number of divisions, and engineer structure (from command and control elements to echelons above corps units) in the three TAAs. The engineer combat battalion (mechanized) used in this discussion is an example and does not represent actual battalion losses.

Figure 1 shows the type of scenarios and number of divisions used in each TAA. In TAA-96, each theater was allocated engineer forces. For example, the number of engineer combat battalions, (corps mechanized) required for Europe was 15; Southwest Asia required 5; and Northeast Asia required 5; making a total of 25 battalions.

During TAA-99, the types of scenarios changed from major theaters to regional contingencies. What was previously called Southwest Asia was changed to Major Regional Contingency-East (MRC-E); Northeast Asia was changed to Major Regional Contingency-West (MRC-W); and Europe remained the same. The number of engineer units required in TAA-99 was based on whichever two scenarios (MRC-E + MRC-W or Europe) required the majority of forces. For example, engineer combat battalion (corps mechanized) requirements for MRC-E was 5; requirements for MRC-W also was 5, making a total of 10; Europe required 15 battalions. The total battalions required for TAA-99 was 15 because Europe was the largest theater.

In TAA-2001 the scenarios changed again, as shown in Figure 1, but the divisional force remained at 20 divisions. The European theater is no longer considered a major theater. The scenario used by CAA was: MRC-East + MRC-West + Forwarded Deployed Europe + Unique = the total force. Korea is included in MRC-West. A "unique" requirement is a one-of-a-kind unit, such as a prime power battalion.

For example, the number of engineer combat battalions (corps mechanized) required for MRC-E was 5 + MRC-W was 5 + Forwarded Deployed Europe was 1 + Unique was 0, making a total requirement of 11 battalions.

The number of units shown in column TAA-01 in Table 2 is the programmed engineer structure as of FY 95.

In the past, the majority of engineer units lost were component (compo) 4, which means they were required by doctrine but were unmanned and unresourced. However, during the TAA-99 and TAA-01 processes, actual active and reserve organizations were selected for inactivation.

In the TAA process, only the type of organization (i.e. engineer combat battalion (corps mechanized) is selected. The actual unit to be eliminated is selected by the MACOM, i.e. 00th Engineer Combat Battalion, Corps Mechanized.

Future Force Structure

What will the engineer force structure look like as we enter the 21st century?

The bottom-up review identified two future planning scenarios: Iraq against Kuwait and Saudi Arabia, and North Korea against the Republic of Korea.[5] The force structure required to fight and win those two "nearly simultaneous major regional conflicts" will be 18 divisions (10 Active Component divisions, 15 enhanced National Guard brigades, and 8 National Guard divisions). Previous publications have described the future force structure as having 10 active divisions and 15 enhanced reserve brigades, with five divisional headquarters[6]. That structure, however, was changed in the past few months. The current and future divisional force structures, as of March 1994, are compared in Figure 2, page 47.

In response to regional contingencies and to advance our national interests, forward-deployed forces will continue to play an important role. Army forces should remain at the current strength in Europe and Northeast Asia. Army forces in Europe will participate in two multinational corps with German units. They will train for rapid deployment outside Europe and for peacekeeping missions, as well as for the traditional mission of stabilization in central Europe.[7]

Engineer Force Structure

	Organization	TAA 96 AC/RC	TAA 99 AC/RC	TAA 01 AC/RC
Division	EN BN, ABN	1/0	1/0	1/0
	EN BN, AA	1/0	1/0	1/0
	EN BN, LID	2/1	2/1	2/1
	EN BN, HVY	0/7	0/0	0/0
	EN BN, HVY ERI	20/3	20/27	19/27
	EN CO, ACR	3/2	2/1	1/1
	EN CO, LTACR	0/0	0/0	1/0
	EN CO, HSB	1/5	1/4	1/4
	EN CO, SIB	2/4	2/1	1/1
Corps	EN BN, WHEEL	0/30	1/10	1/10
	EN BN, MECH	4/4	3/15	3/14
	EN BN, ABN	1/0	1/0	1/0
	EN BN, LT	1/0	1/2	1/2
	EN CO, CSE	6/15	7/30	6/21
	EN CO, LT EQUIP ABN	1/0	1/0	1/0
	EN, CO, LT EQUIP	1/0	1/2	1/2
	EN CO, MGB	5/17	4/11	2/9
	EN CO, AFB	4/11	6/14	5/6
	EN CO, TOPO	0/0	0/0	3/1
Echelons Above Corps	EN BN, CBT HVY	11/29	7/27	7/29
	PRIME POWER BN	0/0	0/0	1/0
	HHC, TOPO BN	3/1	3/1	3/0
	EN CO, TOPO	6/3	5/2	2/0
	EN CO, CSC	1/8	0/8	0/8
	EN CO, PORT CONSTR	1/2	1/2	0/3
	EN CO, PIPELINE	1/3	1/3	0/4
	EN CO, DUMP TRUCK	0/4	0/8	0/8
Command and Control	ENCOM	0/2	0/2	0/2
	BDE, TA	1/4	0/3	0/3
	GROUP, EAC	2/9	1/6	1/5
	BDE, CORPS	2/2	2/2	2/2
	GROUP, CBT	1/10	2/8	2/7
	BDE, DIV	8/0	8/7	8/7

Table 2

Engineer Divisional Force

The Active Component engineer force will consist of 10 divisions: six heavy, one airborne, one air assault, and two light. Each of these divisions will have three active brigades; they will not have the round-up or round-out reserve brigades they have today. The engineer support programmed for each division will be:

- Six heavy divisions - one engineer headquarters and headquarters detachment (HHD) and three engineer battalions
- One airborne division - one engineer battalion
- One air assault division - one engineer battalion
- Two light divisions - one engineer battalion per division

In addition to the divisional units, there will be one armored cavalry regiment, one light armored cavalry regiment, and one heavy separate brigade, each with an engineer company for support, as they are configured today.

The National Guard force structure will consist of 15 enhanced brigades and eight divisions. The 15 enhanced brigades will consist of:

- Seven heavy brigades - one engineer battalion (heavy division) per brigade
- Seven light brigades - one engineer company (separate infantry brigade) per brigade
- One armored cavalry regiment - one engineer company (armored cavalry regiment).

The enhanced brigades will be authorized 5 percent above their personnel strength. Ten of the 15 brigades will have training affiliations with active brigades and should be equipped in the same priority as their active counterparts. The goal of the enhanced brigades is to be mobilized, trained and prepared for deployment within 90 days. If these brigades are realigned to a divisional structure, the command and control will come from the eight National Guard Division headquarters.

In addition to the 15 enhanced brigades, the National Guard will retain the eight divisions they have today. However, the type of the divisions will change to:

- Four heavy divisions - one HHD and three engineer battalions
- Three medium divisions - one engineer battalion per division
- One light division - one engineer battalion

Current and Future Engineer Force Structures

Current (TAA 01) -

Active	**National Guard**
8 - Heavy Divisions	**7 - Heavy Divisions**
1 - Airborne Division	**1 - Light Division**
1 - Air Assault Division	
2 - Light Divisions	

Future (TAA 03) -

Active	**National Guard**
6 - Heavy Divisions	**15 - Enhanced Brigades** **7 Heavy** **7 Light** **1 ACR**
1 - Airborne Division	**4 - Heavy Divisions**
1 - Air Assault Division	**3 - Medium Divisions**
2 - Light Divisions	**1 - Light Division**

Figure 2

Engineer CS AND CSS Requirements

At this time, the combat support (CS) and combat service support (CSS) structures required for the 18 divisions are unknown. However, the eight National Guard divisions will not be programmed CS or CSS organizations because that structure will already be in place. These requirements will not be determined until Phase III of TAA 2003 is completed.

Future Planning

The Engineer School is now preparing for TAA-2003, which begins this fall. Numerous conferences are scheduled with "key engineer players" who represent the Combined Arms Center, CINCs, Chief of Engineers, and ODSCOPS. The school's mission is to ensure that the allocation rules applied adequately reflect engineer doctrine and that the "right mix" of engineer forces will be available to support future Army requirements. Decisions concerning that structure will be made throughout 1995 as the programmed force evolves and is modelled. Since the TAA process never ends, our senior leaders will continue to modify the engineer force structure to support the Army's response to the changing threats to our nation's security.

Mr Malley is a military equipment and personnel analyst in the Directorate of Combat Developments, U.S. Army Engineer School. Before retiring from the Army, he held positions in engineer, armor, and infantry units. Mr Malley holds a master's degree from Webster University.

End Notes

[1] The Bottom-Up Review, 1 September 1993, page 1-2.

[2] Army Command, Leadership, and Management, 1992-1993, pages 11-12.

[3] Ibid, pages 10-11 and 10-12.

[4] Ibid, pages 11-12, 11-13, and 11-14.

[5] The Bottom-Up Review, 1 Sep 93, page 5.

[6] Ibid, 17.

[7] Ibid, page 14.

The Corps of Engineers and the Origins of Federal Disaster Relief

*By Dr. Martin Reuss**

The 1993 midwest flood ranks among the most catastrophic disasters in our nation's history, shattering previous stage and discharge records on major portions of the Mississippi and Missouri Rivers. More than 500 Corps employees were involved in the flood response, and the agency supplied 31 million sandbags and loaned 430 pumps to local interests. Along with other federal and nonfederal agencies, the Corps helped drain flooded areas, conducted damage surveys, and inspected and repaired levees.

As impressive as the Corps' capability to respond to disasters such as the midwest flood is now, this mission was not envisioned by early champions of the Corps. Instead, it evolved after Congress and the public recognized that the Corps' organization and capabilities made the agency a valuable resource that was tailor-made to meet the urgent demands brought on by calamitous disasters.

Civil War Era

Some federal legislation was passed to alleviate the distress caused by several disasters prior to the Civil War, including the loan of naval vessels to transport private, charitable contributions to the famine-stricken people of Ireland. But direct federal participation in disaster assistance really began in 1865, at the close of the Civil War, when the government helped freedmen (freed blacks) of the south survive flooding along the Mississippi River. Once disaster relief had been given to one group, it became legally and ethically difficult for members of Congress to oppose extending similar assistance to others.

The Bureau of Freedmen administered the first federal

The Cambria Iron Works warehouse shows debris resulting from the 1889 Johnstown, Pennsylvania, flood.

Refugees and livestock retreat on a levee opposite the lower end of Island 8, near Hickman, Kentucky, during the 1912 Mississippi River flood.

disaster-relief program from 1865 to 1872, and then the Army Quartermaster Corps became responsible for this slowly expanding responsibility. The Corps of Engineers, however, with men and equipment stationed along the inland rivers, was the best suited federal agency to perform rescue and relief work during flood disasters. Consequently, although the Quartermaster Corps retained overall administrative control, the execution of relief operations during floods became the Corps' responsibility. The Corps of Engineers performed its first disaster-relief mission during the Mississippi River flood of 1882, when they supported Quartermaster Corps efforts to rescue people and property. Congress also directed the Corps to distribute Quartermaster Corps' supplies during flood disasters.

Thus, by the late 19th century, the words "flood fight" automatically produced in the minds of the public a vision of Army engineers directing men heaving thousands of sandbags into place or steaming up bayous to pick people out of treetops. In the aftermath of the catastrophic Johnstown, Pennsylvania flood of 1889, which killed 2,209 people, the government used engineer troops for the first time for emergency disaster relief. In this effort, troops cleaned up debris and built temporary pontoon bridges. The special training and experience of the engineers soon brought other disaster-relief missions: preparing damage surveys, placing temporary bridges, and fighting civil conflagrations. Those missions were assigned to the Corps by the President, the Secretary of War, and Army Department commanders.

Early 1900's

The engineers believed that disaster relief, as administered by the Quartermaster Corps, hampered flood fights and had other unfortunate consequences. After 1913, the engineers proposed substituting a "no work, no rations" policy, or work relief, for disaster victims instead of free rations distribution, and in 1916 Congress gave the engineers an opportunity to implement that new policy. For a short time, in 1916, the Corps of Engineers replaced the Quartermaster Corps as the primary administrative agency for federal disaster relief. During that period the engineers conducted a work-relief program that foreshadowed activities of the "alphabet" agencies that developed during the Depression years.

In 1917, the Army reorganized its disaster-relief responsibilities and assigned command and control during disaster situations to department or corps area commanders. The engineers retained their responsibility for the preservation of navigation channels and flood-control structures, but during the rescue, relief, and recovery phases of disasters both the engineers and the quartermasters acted in support of the American Red Cross.

Some disasters exceeded even the Red Cross' resources and capabilities. To facilitate relief for those disasters, the Executive Branch began in 1927 to appoint federal disaster-assistance coordinators, who supervised the activities of the Red Cross, the Corps of Engineers, the Quartermaster Corps, and all other interested federal agencies. During the

A 7th Army soldier clears Highway 83, near Minot, North Dakota, during Operation Snowbound, in 1949. More than 6,000 snowfighters cleared 115,000 miles of snow-blocked roads in that operation.

Depression years, disaster-relief efforts were also strengthened by manpower supplied by such agencies as the Works Progress Administration and the Civilian Conservation Corps.

1940s and Beyond

The engineers improved their disaster responses after the extensive 1937 floods by initiating emergency operations planning. This initiative resulted in a perceptible improvement in readiness and a new aggressiveness in reaching disaster sites and furnishing needed relief. That planning reaped important benefits during World War II, when it became necessary to use engineer troops and prisoners of war for flood fights and other disaster operations. Their readiness was also apparent during such post-war disasters as the 1947 Texas City explosion, which killed 512 people and injured 1,784, and during Operation Snowbound in 1949.

Operation Snowbound, the first snow-removal emergency for the Corps, covered most of the states in the Missouri River watershed. Eventually it involved nearly 2,000 Corps of Engineers personnel, including 807 Army officers and more than 4,000 contractor employees. Lieutenant General Lewis Pick, the Chief of Engineers, had used 394 bulldozers during the peak construction period on the Ledo Road between India and Burma during World War II. During Operation Snowbound, he put 1,320 bulldozers to work. In that operation, Corps efforts succeeded in opening 115,000 miles of road, providing supply access to more than 243,000 people, and providing access to feed for more than 4 million livestock. Operation Snowbound was the first disaster-assistance mission for which Army Commendation Ribbons were awarded. Of the six enlisted men thus distinguished, two (Corporals John Donnelly and Melvin Shoemaker) were from the Corps of Engineers.

By 1950, the Corps of Engineers had an established reputation for swift and effective response. The Corps' geographic organization and special training had brought the agency a wide variety of disaster-relief missions, and Army engineers had built on that experience to improve their emergency readiness and response. Some engineer officers in 1950 thought the entire federal disaster-assistance program should become an engineer mission, just as it had been in 1916.

The Army General Staff, however, fearing that disaster-relief work might interfere with national defense responsibilities, did not approve of involving the Army in what they viewed as a civil function. Nevertheless, under the Federal Disaster Relief Act of 1950, the Corps of Engineers preserved its role as the leading federal agency during flood disasters, and other governmental relief agencies learned that they could rely on the Corps of Engineers to respond in its customary "Essayons" spirit.

**Note:* This article is largely based on, and occasionally paraphrases, an unpublished manuscript by Leland R. Johnson, "Emergency Response: the Army Engineer Disaster Relief Mission, Origins to 1950." The manuscript is in the records collections of the Office of History, Headquarters, U.S. Army Corps of Engineers, Arlington, Virginia.

Dr. Martin Reuss is a senior historian in the Office of History, Headquarters, U.S. Army Corps of Engineers, Alexandria, Virginia.

ENGINEER UPDATE

Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

New Director Welcomed. We welcomed LTC Thomas J. Hodgini, our new director, in March. LTC Hodgini previously served as Chief, Force Integration Division, Directorate of Combat Developments, at the Engineer School. LTC Hodgini may be reached at -4093.

Engineer Officer Advanced Course (EOAC). Students attending EOAC classes now receive 80 hours of training on Janus computer simulations, double that received previously, so they can conduct both an offensive and defensive exercise. This "hands-on" tactics exercise requires students to perform the roles of the combined arms task force staff. The objective is to reinforce tactics instruction and prepare students for future simulation warfighters like the Battle Command Training Program. POCs are MAJ Susan Myers or SFC Samuel Campo, -4124.

Directorate of Combat Developments (DCD)

Concept Evaluation Program (CEP). The Engineer School is the proponent of three CEPs in FY 94: the Assault Breach Marking System, the Command Post/Bunker; and Multi-Spectral Camouflage Systems for Mobile Equipment. The CEP is a Training and Doctrine Command (TRADOC) program that provides quick, innovative testing to resolve training and combat development issues. Proponents such as the Engineer School use the program to refine materiel requirements or determine the operational and training potential of new materiel. Nonmaterial applications, such as testing of doctrine or organizations, is limited to instances where confirmed troop support is available from another Major Command. The CEP is not intended to circumvent normal testing requirements of the materiel acquisition process and is not planned as the primary test to support a production decision. The process is initiated each July, when proponents submit CEP candidates to the appropriate Battle Lab for review, validation, and forwarding to HQ TRADOC. A review committee meets in August to prioritize the candidates and determine which will be funded. POC is CPT Chris Newton, -4082.

Directorate of Evaluation and Standardization (DOES)

Operations Other Than War (OOTW) After Action Report. Engineer observations from OOTW will be described in an AAR to be distributed in May. The AAR provides recommendations to help engineer units improve on-going training readiness and leadership development. It includes hurricane, earthquake, and flood recovery operations as well as humanitarian assistance in Somalia and nation assistance in Central America. Comments are welcome. To provide information or receive additional copies, write: USAES, Attn: ATSE-ESA, Fort Leonard Wood, MO 65473-6630. POC is Vern Lowrey, -4007.

Post-Fielding Training Effective Analysis (PFTEA) for the Armored Combat Earthmover (M9 ACE). Emerging results from the PFTEA indicate that units with high operational readiness rates on the M9-ACE exhibit common characteristics:

- High level of supervision over ACE operations.
- The level of supervision increases as the amount of ACE operation time increases.
- ACE operators with less than 12 months of experience are supervised more than other operators.
- ACEs are used in teams not as single units.
- New equipment training is given and reinforced for both operators and mechanics.

The bottom line is that supervision is the key to maintaining a high operational readiness rate for the M9-ACE. A final report is scheduled for publication this summer. POC is Peggy McAvenia, -4009.

Engineer Branch Safety Office

New Director Welcomed. We welcomed James G. Runge, our new director, in February. Mr. Runge came to us from the Defense Logistics Agency, Defense Contract Management District North Central, in Chicago. He is a sergeant major in the Army Reserve, serving in the office of the DCSOP, 86th USARCOM. Mr. Runge may be reached at -4024.

Explosives and Demolitions. The best way to avoid accidents on demolition ranges is to have properly trained and certified range personnel, be in compliance with minimum safe distance requirements, and perform to standards. Standards for using explosives and demolitions are in AR 385-63 and FM 5-250. POC is Paul Rusinko, -4024.

Engineer Personnel Proponency Office (EPPO)

Military Occupational Specialty (MOS) 12C, Bridge Crewmen. Women bridge builders will soon be assigned to 12C positions in divisional engineer brigade headquarters, medium girder bridge companies, and assault float bridge companies. MG Ballard, Commandant of the Engineer School, has approved opening MOS 12C to female soldiers. MOS 12Z (Combat Engineering Senior Sergeant) was also opened to females in the headquarters company of engineer battalions and above (brigade, corps, etc.) to allow for career progression. POC is MSG Tom Crow, -4087.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

The theme for this year's Senior Engineer Leaders Training Conference (SELTC) is "Versatility and the New Strategic Era." The Corps of Engineers is growing, not in greater numbers but through "progressive development." This is the projected vision of the Engineer School's Commandant.

For those senior leaders who attend, conference speakers will reveal the future of the Engineer Corps, concentrating in three key areas: training, processes/-systems, and personnel. Our goal is to involve Active and Reserve Components equally in all activities. It will be the responsibility of those who attend to take the information back to their units and disseminate it to the lowest levels. Major topics to be discussed follow.

Training. This is the cornerstone of readiness and the basis for our Army's credible deterrence and capable defense. Training is the means by which engineer soldiers and leaders develop their warfighting proficiency and exercise the collective capabilities they will require in combat. My goal at the conference is to involve each senior NCO leader in a review of—

- The individual critical task list for the combat and sustainment engineer military occupational specialties (MOS), for Career Management Fields (CMFs) 12, 51, and 81.
- The programs of instruction (POI) for the Basic Non-Commissioned Officer Course. The POIs reflect the learning activities to be implemented to train, in resident, those tasks within subject areas outlined in MOS training plans for the three CMFs.

Army leaders must ensure that the individual tasks taught at both resident and unit levels support our collective mission essential task lists (METLs). We cannot afford to waste valuable training dollars on training that does not support engineer missions. Training dollars are shrinking, and we must judiciously follow the principles outlined in FM 25-100 and FM 25-101 in all resident and unit training.

Processes/Systems. Some of the processes and systems to be discussed at the SELTC include the Battle Lab process, the new heavy assault bridge (HAB) and the new breacher.

Battle Labs provide a framework for merging new technologies with requirements. Networking is a key component of the Battle Lab concept. The labs are linked electronically and allow us to control change, direct it, and guide it for our benefit. The Battle Labs allow us to refocus the Army's modernization efforts from a stove-piped, proponent-oriented process to a horizontal process that simultaneously addresses several systems. The Battle Lab process encourages innovation and benefits the entire Army.

The mobility capabilities of combat engineers will increase with the procurement of two new systems. The Heavy Assault Bridge (HAB) is scheduled for fielding in the 1st quarter of FY 99. The Breacher, also called the "Grizzly," is scheduled for fielding in the 4th quarter of FY 99. These systems will add new meaning to the term "battlefield mobility."

Personnel. Personnel issues to be discussed include operational assignments, institutional training, and self-development.

Operational assignments are the catalyst for leader development. Senior leaders play a critical role in the development of our junior leaders. Therefore, we must ensure that unit leader development programs meet the needs of both our organizations and our junior leaders. This is accomplished through varied assignments and METL-based training.

Institutional training, the formal resident training conducted in the Army Schools System, also is critical to leader development. Senior leaders must seek opportunities to send their soldiers to competitive institutional training, such as the Primary Leader Development Course, the Basic and Advanced Noncommissioned Officer Courses, and the Battle Staff Course. These courses benefit both the unit and the individual soldier.

Self-development programs enhance the soldier's overall professional competency. For it to be effective, senior leaders and their soldiers must share responsibility for maintaining and increasing proficiency. Senior leaders must determine where soldiers are along their career path and help them design a meaningful plan for future development. Their plan should include professional reading, correspondence courses and civilian education.

The senior leaders who attend the 1994 SELTC should come prepared to share their professional views on the future of the Corps of Engineers and our Commandant's vision. His vision will take us into the year 2000 and beyond, and we must support it.

Wheeling, West Virginia flood conditions, March 18-19, 1936.

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Robotics Technology

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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

Versatile. Dynamic. Flexible. Diverse. These terms are often used to describe the soldiers, leaders and units that comprise the Corps of Engineers. They identify the qualities that our Army expects from us, and they are evident in all that we undertake and accomplish. As I look at the wide range of missions our Corps is performing, it is clear that these attributes are well deserved.

Engineer soldiers have repeatedly risen to the challenges of a changing world and they stand ready to meet any challenges the future may bring. It is likely that future challenges will push us beyond our established doctrine and tactics, techniques and procedures (TTPs) into new mission areas. As engineer soldiers, your demonstrated ingenuity and versatility in accomplishing these rapidly evolving missions are astounding.

I encourage you to share your experiences with new missions and new equipment with others in the engineer community. I challenge you to share your experiences and lessons learned throughout the entire Corps. *ENGINEER* magazine is an excellent forum to accomplish this dialogue. The Engineer School is your clearing house for observations, lessons learned and development of TTPs to meet our missions. We are here to serve you.

The missions performed by engineers in the recent past have covered the full breadth of our doctrine: humanitarian assistance to victims of natural disasters, Civil Works' response to the great floods of 1993 and 1994, creating infrastructure in support of forces in Somalia, combat engineering in Southwest Asia, and host nation support throughout the world. In many cases, engineers created the TTPs in use today to meet specific needs in the past. Future nondoctrinal missions facing our Corps, which include the possibility of demining operations (see article, page 20), will expand our established doctrine and TTPs. These potential missions, combined with developmental and contingency operations equipment, will allow timely formulation of TTPs based on user input. Your voice is critical to successfully meet the TTP challenges of the future.

My staff at the Engineer Center continues to explore advances in technology and their application to mission areas. Articles in this issue of *ENGINEER* by Dr. Robert Sickler and Captain Robert Berg discuss some applications being explored in the field of robotics technology and their impacts on TTPs. Your school is also aggressively integrating future engineer systems with all of the TRADOC Battle Labs through advanced warfighting experiments (AWEs). Of note are experiments in the countermine arena, which explore technologies aimed at improving the effectiveness of early entry forces to detect, avoid and clear mines and submunitions.

The technologies and systems that prove effective in the AWEs will be pursued for either Army procurement or contingency operations procurement. Many of you will have an opportunity to use these developmental systems during training rotations at the National Training Center and Joint Readiness Training Center currently scheduled for FY 95. Here, too, your feedback concerning these new systems is critical for program success.

I am excited about the future of the Engineer Corps and the challenges we will face. With your involvement, engineers will continue to "Clear the Way" for our Army. The missions that we face today are no more challenging and uncertain than those faced by our forefathers. I am confident that the engineer soldiers and leaders of today and tomorrow will continue to earn the motto "ESSAYONS"!

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Cover photo: *Remote controlled vehicle breaks through road obstacle to allow MP forces to rescue ambushed scout element during demonstration for Under Secretary of the Army, The Honorable Joe R. Reeder. Photo by Jim Anderson.*

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Photo by Jim Anderson

Projecting Robotics Technology in Operations Other Than War

By Dr. Robert A. Sickler

A-TIA

Robotic-Technology Insertion Activity FLW

Force Projection Through Robotics

National interests and objectives have presented the United States military with the unique challenge of transitioning from an European focused mission to one of global force projection. Thanks to the technological might of the United States, our military has successfully met part of this challenge by developing ways of engaging the enemy beyond his range of retaliation. A new and emerging capability for this projection of force through technology is the use of unmanned vehicles and military systems. Called "robotics" by the civilian community, this technology has the potential to change the nature of warfighting and the way in which soldiers conduct operations other than war (OOTW).

The U.S. military is no longer focused on stopping a Soviet horde as it attempts to plow through Fulda Gap. Our new national military strategy calls for the U.S. military to project force as a means of preventing or bringing to an end international situations that threaten the welfare of our nation or the welfare of friendly nations that request aid. To meet today's requirements, we must carefully design a contingency force that can react to an international situation with sufficient force to accomplish the mission, yet not so great a force that it escalates resistance.

University Compound in Somalia. Inside the "fort" it was relatively safe; outside it was all enemy country.

To project a limited force capable of removing or neutralizing a volatile international situation is not easy. In such operations, there is a great risk to mission success: Too little force can result in too many soldiers dying or even in military failure, but too much force can result in escalation to full-scale war. Even though it is risky, our nation cannot ignore an external situation that threatens the U.S. or our allies. What we can do, however, is develop technologies such as robotics, which will allow us to project force through machines—not human lives. Such technology gives us the ability to limit the projection of force without the negative impact of losing lives as a result of insufficient force.

Recognizing the potential of robotics in force projection, the U.S. Army Engineer School initiated a program to exploit this new and emerging technology. To maximize the return on investment, the Engineer School has chosen to upgrade existing military systems through the horizontal insertion of robotics technology. During this period of downsizing and constrained budgets, technology insertions are the preferred method for material acquisition.

Engineer Vehicle Teleoperation

Horizontal insertion of robotics technology is being developed through the Engineer School's Engineer Vehicle Teleoperation (EVT) program. The concept of EVT operations is to enhance the war-fighting capabilities of existing military systems. A major program requirement is that the inserted robotics technology must not interfere with manned operation of the vehicle. A second requirement is that, when operated in the unmanned mode, the robotics technology must allow a remote operator to perform vehicle functions compatible with manned operation. Program objectives are near-term contingency fielding of select EVT systems and eventual fielding of EVT systems to force package one units.

Under the current EVT program, a limited number of systems that support contingency force operations will be fielded at Fort Leonard Wood in 1995. A training circular is being written and a new equipment training (NET) team is being established to support the 1995 fielding effort. A select number of systems will go into contingency storage, and one or two systems will be fielded to the Engineer School's Robotics-Technology Insertion Activity (R-TIA) to support NET training (see inset, page 9). Should a situation arise where EVT capabilities are required, the systems and a NET team will be ready for immediate fielding to the contingency force. Plans are underway to follow the initial contingency capability with a larger interim fielding effort in 1997. Full-scale fielding of EVT block upgrades to force package one units is scheduled to begin about 1999.

A significant attribute of the EVT program is its ability to take a less-than-desirable existing system and make it deployable. For example, several vehicle-mounted, mine-detection systems are capable of finding a limited number of mine types, but no one system can find all mine types. As a result, the Army has not fielded any vehicle-mounted, mine-detection system. Army rationale for not fielding is based on the fact that anyone operating a system that cannot find all mine types would almost certainly die. The solution to this dilemma is to mount the less-than-perfect technology on a vehicle equipped with EVT capability. That way, a mine-detection mission can be carried out and, when the inevitable happens, only a vehicle is damaged; no life is lost.

Unmanned operation of vehicles in highly hazardous situations has other attributes besides eliminating risk to the operator. One key enhancement is an increase in vehicle survivability. Data gathered through the EVT program show that unmanned armored target vehicles used in munitions testing have taken numerous hits from

Photo by SPC Virginia Espree

Evaluations at Fort Leonard Wood have proven that it doesn't take long to construct an effective route obstacle out of old vehicles.

high explosive rounds and remained functional. One piece of this data is a video tape that shows an armored vehicle taking a direct hit from a copperhead missile, and the vehicle keeps driving down the road. The increase in survivability, in conjunction with the "willingness" of an unmanned vehicle to take on any mission, significantly increases the probability of mission success.

Robotics technology, when inserted in existing military systems, offers an economic enhancement to the system's warfighting capability. Nowhere is this more evident than in meeting the demands of operations other than war.

OOTW Challenges

One of the most difficult situations for any military organization is to be in a hostile environment when there is no declared war. In such situations, all terrain outside the limited areas of occupation becomes a risk to soldiers' lives. Additionally, the antagonists are not well defined, and the very fluid battlefield is defined only by events taking place at the time we are on the field. When conflict exists on this kind of battlefield, "rules of engagement" often are vague and poorly suited for the ever changing events of "nonwar." Under those conditions, our military's greatest advantage is the ability to project force without putting soldiers in harm's way. If the technology we project causes the threat to cease hostilities, we have achieved victory without generating large body counts. The best way to project force without putting soldiers in harm's way is to let a robot do it!

It is easy to say that OOTW present unique and difficult battlefield challenges, but valid data are required to justify a program to solve them. In 1993, the U. S. Army Engineer School sent a countermine technology team to Somalia to obtain such data. In essence, the team's mission was to determine the contribution of emerging technologies in solving OOTW countermine force-projection requirements.

Somalia MOUT Experience. Somalia proved, once again, that one of the greatest dangers facing U.S. soldiers in OOTW is the ever-increasing use of land mines by the threat. Both mines and unexploded ordnance are major weapons in almost all military arsenals. The Persian Gulf War and the war in Somalia can be viewed as harbingers of escalating global destabilization, where antagonists will capitalize on the warfighting contribution and economics of land-mine usage. As Sun Tzu stated, "It is only one who is thoroughly acquainted with the evils of war that can thoroughly understand the profitable way of carrying it on." For the vast majority of those caught in current conflicts, the land mine is a major evil of war.

In the Mogadishu MOUT (military operation in urban terrain) environment, mobility missions entailed both countering point minefields and reducing barriers that often were reinforced with mines. The Engineer School's initial assessment verified the United Nations Logistics Support Command's request for M728 combat engineer vehicles (CEVs), countermine technologies and a reinforced mechanized engineer platoon. Unfortunately, a decision was made not to take the CEV into Somalia.

Route Obstacle Threat. The Mogadishu MOUT mine and barrier threat was compounded by the fact that U.S. forces did not have a full suite of weapon systems at their disposal. In Somalia, not only did our forces lack the CEV, they also lacked support by

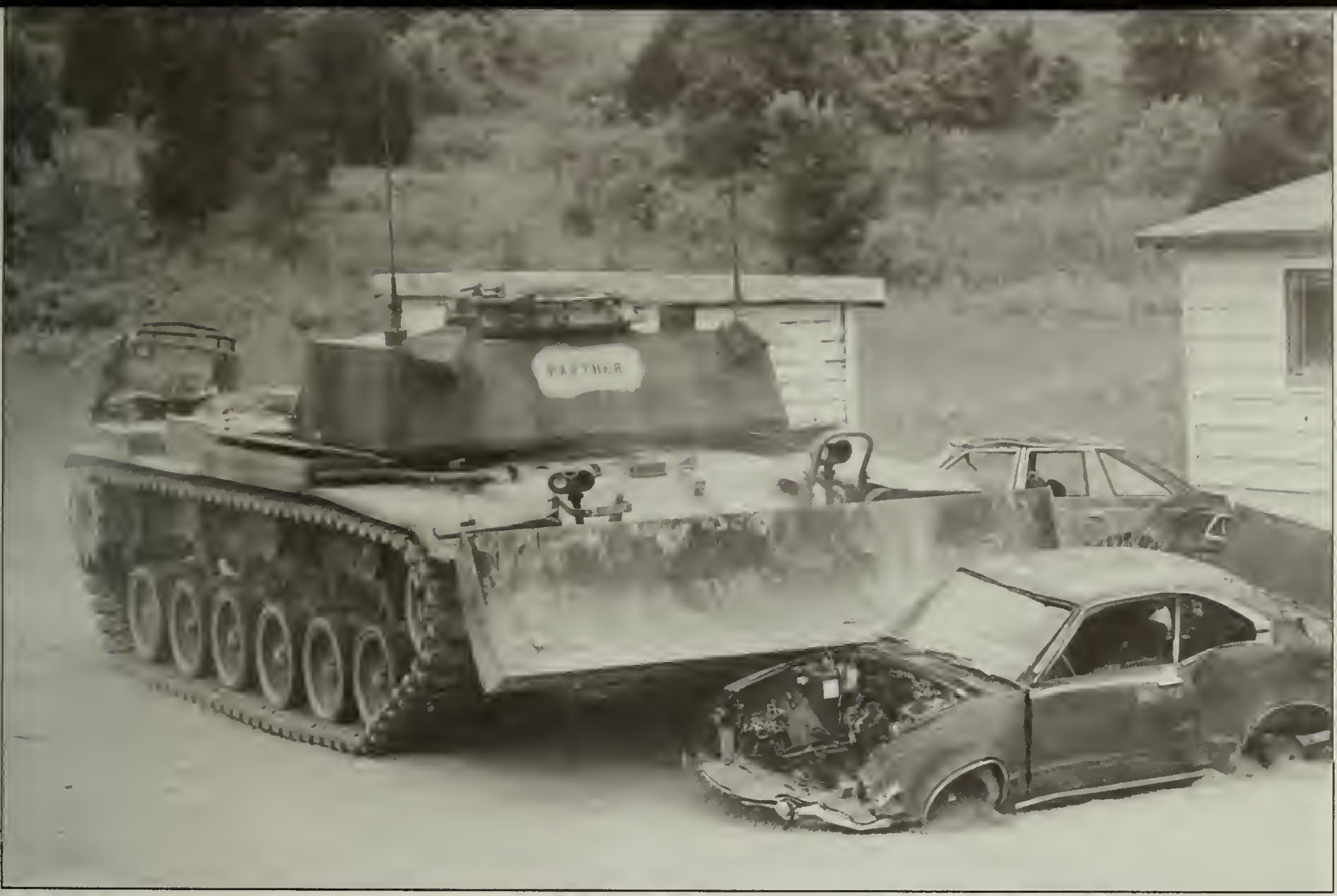


Photo by Jim Anderson

The first generation Panther concept vehicle has proven the versatility of a multi-functional, unmanned armored platform.

armor and field artillery. Under those conditions, the enemy could ambush or attack our soldiers in relative freedom from armor or artillery reprisal—and they did. For example, simple barricades made with cars or junk and covered with antitank weapons stopped HMMWVs and 5-ton trucks.

Because modern threat forces are often equipped with sophisticated antitank weapons, current vehicles such as the CEV have very limited application in MOUT route breaching. Where threat covering fires can be suppressed with armor and artillery, the CEV can effectively reduce barrier obstacles, fortifications and strong points. But in most OOTW we are constrained in the level of force we can project, making manned obstacle reduction extremely hazardous. If our forces in Mogadishu had been equipped with an unmanned, blade-mounted armored vehicle, they could have reduced the barriers easily.

Panther Solution. The route obstacle situation that developed in Somalia motivated the Engineer School to initiate a program to develop an unmanned, route-obstacle breaching capability. The program is designed to capture the route-obstacle breaching attributes of the CEV in an unmanned vehicle that will not be viewed by other nations as a tank. The objective is to have a vehicle that can reduce route obstacles, yet is not considered an escalation in U.S. military presence when introduced in an OOTW environment. One conceptual vehicle now under study is the sapper assault vehicle, code named *Panther*.

The Panther conceptual vehicle is a product of the Engineer School's Robotics-Technology Insertion Activity (R-TIA) and the Joint Projects Office for Unmanned Ground Vehicles/Systems (JPO). After the Panther was constructed, R-TIA, with the support of the Test and Evaluation Coordination Office (TECO) at Fort Leonard Wood, generated a concept of employment evaluation (COEE) to determine its employment potential. The purpose of a COEE is to establish the tactics, techniques, and procedures for a system's employment. It also establishes analytical data on system contributions to or degradation of mission performance, and the system's impact on doctrine (see article, page 10).

Panther is especially designed for OOTW environments. Because it has neither a main gun nor a turret, Panther cannot be classified as a tank. Thus, employment of Panther should not escalate a conflict any more than employment of an armored bull dozer. Unlike a dozer, however, Panther can carry a full squad of engineers and employ numerous combat engineer systems. In addition, Panther can function as the command station for other robotics vehicles or be operated as an unmanned vehicle itself.

Panther's ability to reduce route obstacles, such as the vehicle barriers in Somalia, was demonstrated at Fort Leonard Wood in June 1994. The demonstration was

The Engineer School will soon be ready to meet the next contingency requirement for route obstacle breaching.

presented to the Under Secretary of the Army and was a complete success. In this demonstration, Panther was operated as an unmanned vehicle to conduct an "in-stride" reduction of a route obstacle. Plans are underway to develop a second generation Panther prototype, which will have improved armor and a new (4th) generation remote-control system. Under this plan, the upgraded Panther will be fully operational and deployable for contingency operations by FY95.

Somalia MSR Experience. Another concept initiative generated by the Engineer School's team in Somalia is a program aimed at providing unmanned host vehicles for vehicle-mounted, mine-detection equipment. In September 1993, the school's countermine technology team accompanied the 362nd CSE company commander on a reconnaissance of Main Supply Route (MSR) Red, which was the main route north from Mogadishu through Baidoba. The team's mission was to analyze potential countermine technology applications for MSR Red and determine the best methods of employment. The team recommended converting less-than-perfect countermine capabilities into deployable countermine systems by mounting them on unmanned vehicles.

MSR Red Threat. The countermine technology team's recommendation was based on their evaluation of the characteristics of MSR Red and threat mining methods. MSR Red was approximately 30 kilometers of highly degraded, semi-improved dirt road. Most of the road was compacted insitu materials and crushed coral, which years of traffic had further crushed into a considerable amount of fines. During wet weather the road probably would degrade considerably. The 362 CSE Company's mission was to upgrade the road to semi-improved standards capable of supporting convoy speeds up to 35 miles per hour. They were also tasked to keep the route open, although they lacked both the manpower and the technology to accomplish that mission.

The terrain along most of MSR Red is flat, irrigated farmland. The road is straight except for two closely spaced 90-degree turns and a few long, sweeping curves. More than 55 irrigation culverts (ranging from 12- to 24-inch concrete) cross beneath the route and are found along the entire length of the MSR. The condition of the culverts ranges from poor and without headers to good and with 3-foot headers. Often the elevation of the irrigation ditches is as high or higher than the elevation of the road surface; steep-sloped humps in the road allow traffic to get over the elevated culverts. The road profile varies from a raised road bed to a depressed road bed. Vegetation varies from sparse, low shrubs to moderately sized trees.

Existing traffic along the MSR is primarily by foot or single-axle carts. Small- to medium-sized farm tractors are seen frequently,

Mines and explosives placed in culverts such as this one were a major threat on MSR Red.

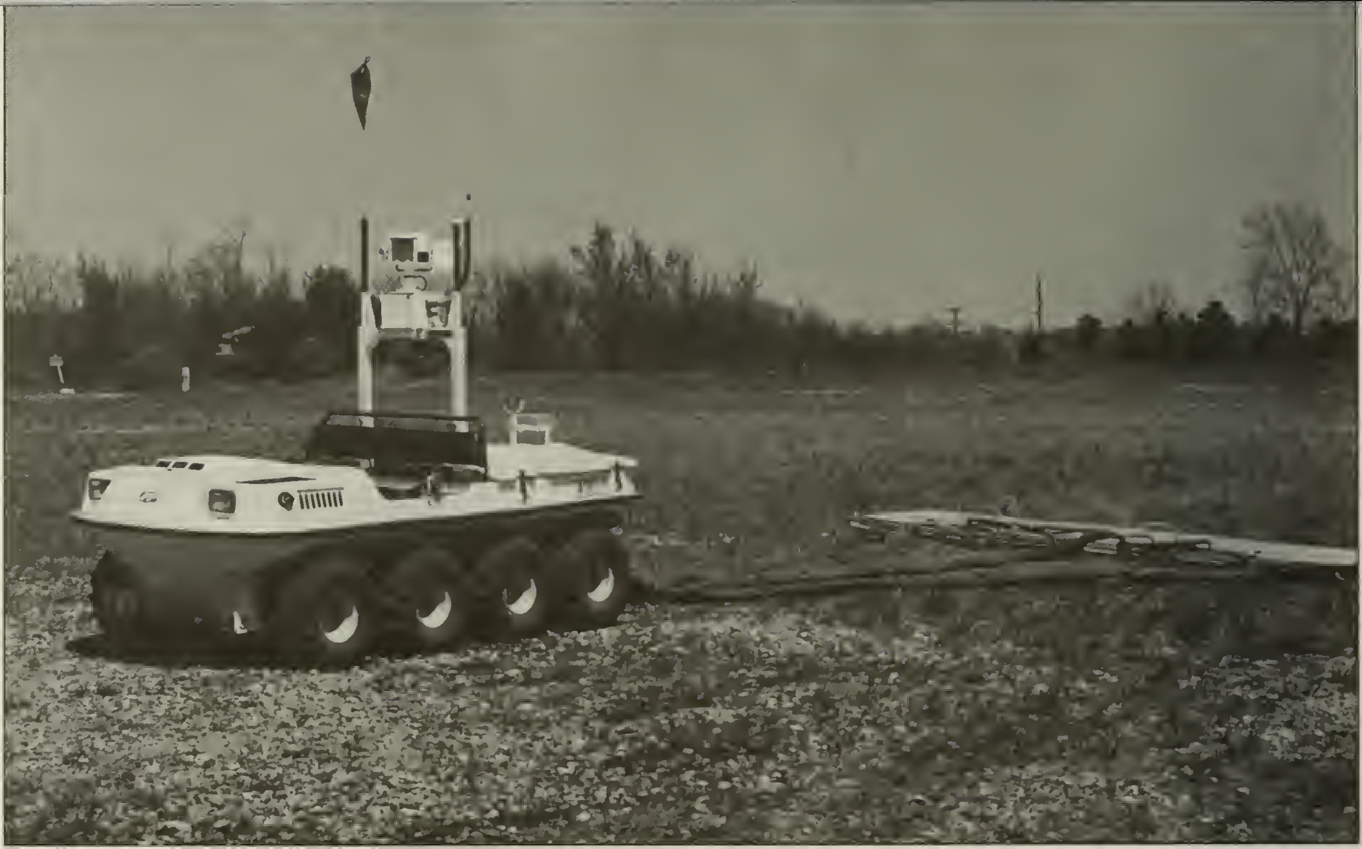
and a few small- to medium-sized, single-axle trucks move farm produce on the MSR.

Intelligence was unable to provide the Engineer School's team with a well defined threat; however, a threat profile was established by extrapolating data from other areas. It was determined that, should the threat move its activity from the Mogadishu area and make a concerted effort to shut down MSR Red, the 362 CSE Company could not keep it open. This assumption was based on the fact that, without a vehicle-mounted, mine-detection capability, the time and logistics required to clear a route the length of MSR Red with hand-held mine detectors was too great.

Badger Solution. Based on the MSR Red study, the Engineer School initiated a concept program in late 1993 to combine several technologies and generate a route clearing capability. Code named *Badger*, this program relies on an EVT system to provide unmanned operation capabilities for existing military vehicles. In Somalia, the principle vehicles available were the High Mobility Multi-Wheeled Vehicle (HMMWV) and the 900-series, 5-ton truck. Because the same vehicles probably will be used in future contingency operations, the Badger program will employ a mine-detection capability mounted on a HMMWV and a proofing/detection capability mounted on a 5-ton truck. Under the current operational concept, the two vehicles will operate in tandem as lead elements in a route-clearing team.

The sequence of operation for this route-clearing team is mine detection, marking, proofing, and neutralization. The unmanned HMMWV, equipped with a vehicle-mounted mine detector and marking system, leads the

Civilian traffic on the MSR can be used by the enemy to mask mining activities or halt convoy movement.



Developed in Canada for contingency fielding to Somalia, Jingoss embodies the concept of unmanned, vehicle-mounted mine detection.

way. An unmanned 5-ton truck equipped with rollers follows the HMMWV and proofs that portion of road cleared by the HMMWV. The third vehicle is the command and control vehicle. When a mine is found and marked by the HMMWV, it backs up and moves around the mine. The HMMWV does not stop but continues on. The 5-ton truck and command vehicle also avoid the marked mine and continue on. They are followed by combat engineers, who neutralize the marked mine. While this is taking place, the rest of the route-clearing team continues forward. Once a mine has been neutralized, the combat engineers move forward to join the rest of the team.

In the initial phase of the Badger program, a study was made to determine the most viable candidate mine-detection systems for mounting on a HMMWV. Two systems were selected for evaluation. The mine-detection system with the longest lead time for fielding proved to have the highest potential for detecting a wide range of mine types. This system employs a commercial infrared camera, whose concept of operation was demonstrated in Somalia by the CECOM Research Development and Engineering Center (CERDEC), at Fort Belvoir. The second system is a vehicle-mounted, metallic mine detector being evaluated by the Program Manager Mines, Countermine, and Demolitions (PMMCD), at Picatinny Arsenal. In the current Badger concept, both systems will be mounted on an unmanned HMMWV.

To help establish an employment concept for the unmanned HMMWV mine-detection portion of Badger, R-TIA conducted a COEE using the Canadian Army's robotics mine detector, *Jingoss*. The Jingoss system is a metal mine-detection array that is pulled by a small, unmanned vehicle. During the COEE, R-TIA evaluated the system's maneuverability and operational characteristics, while CERDEC evaluated its ability to detect mines.

Evaluation results indicate a very high employment potential for an unmanned, vehicle-mounted, mine detection system. At Fort Leonard Wood, Jingoss has demonstrated its capability to detect metallic mines and mines with moderate metal content. The tactics, techniques, and procedures developed for Jingoss by R-TIA can be applied to the Badger system. While it can detect only metallic mines, Jingoss has demonstrated that the operator can be removed from a route-clearing vehicle to make a less-than-perfect solution fieldable.

The second element in the Badger team will be a simple yet robust countermine system for proofing routes. Plans are to employ a rubber-tired mine detection roller used to detect single-impulse mines. The PMMCD is working with the Engineer School and JPO to select the best roller configuration for the Badger program.

Plans call for an unmanned 5-ton truck mounted with South African style rollers to be tested at Fort Leonard Wood in the first quarter of FY95. Once at R-TIA, the system will undergo an extensive evaluation. Because roller technology is already mature, this portion of the Badger system will be ready for contingency fielding in 1995. The initial fielding will be followed by the intermediate fielding of a fully developed Badger system in 1997.

ESSAYONS

Our involvement in Somalia was the United States' first major attempt at limited force projection in an operation other than war where the conflict became a protracted affair. Somalia proved that, when warfighting capabilities are constrained by politics, time enhances the effectiveness of the threat's countermobility efforts. The message is clear: U.S. forces must be supported by the best mobility and countermine assets available in all future OOTW operations.

Army engineers require a way to successfully breach route obstacles in contingency operations. They also require the capability to promptly detect and neutralize land mines on routes and areas adjacent to key terrain. Existing and emerging technology for obstacle breaching and mine detection and neutralization are not perfect, and the U.S. is unwilling to field partial solutions that unduly endanger soldiers. To take soldiers out of harm's way, the Engineer School is working to put less-than-perfect solutions on unmanned vehicles. By removing the operator, these systems become viable and deployable assets that engineers can employ in countermine and mobility missions. The Panther and Badger programs project force through technology—not human lives.

Dr. Robert Sickler is the manager of R-TIA, U.S Army Engineer School. Dr. Sickler has more than 12 years' experience in robotics and a PhD dissertation on the automation of construction and mining equipment.

Robotics-Technology Insertion Activity

By Robert L. Hill

Fort Leonard Wood's Robotics-Technology Insertion Activity (R-TIA) was created at the U.S. Army Engineer School to support the development and fielding of robotics systems. The goal is to remove soldiers from hazardous situations and save lives. Robotics technology allows engineers to operate mine detection systems, breaching vehicles, and other engineer equipment from an over-watch position. Putting this complex new technology into the hands of soldiers demands a fully integrated effort that covers the entire DTLOMS (doctrine, training, leadership, organization, material, and soldiers) spectrum.

The material developer responsible for producing robotics solutions to battlefield deficiencies is the Office of the Secretary of Defense's Joint Project Office for Unmanned Ground Vehicles/Systems (JPO) at Redstone Arsenal. R-TIA, working with the Operational Test and Evaluation Command (OPTEC) and TRADOC Battle Labs, supports this effort by providing early soldier input and DTLOMS consideration throughout the developmental process.

R-TIA's involvement allows JPO to take a robotics system off the laboratory bench, put it in an engineer vehicle, and evaluate it in an employment scenario. By putting prototype systems in a real-life environment, R-TIA can ask questions and validate answers needed to support system fielding. Problems that contractors may overlook often become apparent in the dust, heat, cold or darkness of Fort Leonard Wood's UGV maneuver range.

R-TIA includes the following three sections:

- Operations is responsible for providing field evaluations that assist in developing and validating the tactics, organizational structure, employment procedures, system design and training for each prototype system. Fielding involves more than simply placing a package on an engineer vehicle to create a remote controlled vehicle. Questions such as how a robotics vehicle is best employed and how operators will be trained must be answered and validated. Most of this effort is conducted at R-TIA's UGV maneuver range.
- Engineering provides limited technical support to integrate robotics into fielded engineer systems. While JPO is the material developer, R-TIA engineers can make adjustments or minor modifications, often eliminating the need to return a system to a contractor or lab.
- Support is responsible for administration, supply, equipment maintenance, and real property maintenance.

The Engineer School is committed to working with JPO, TRADOC Battle Labs, and others to expedite the fielding of robotics systems that meet engineer force requirements. With R-TIA's support, the Army will soon field robotics systems that remove soldiers from the hazards of the modern battlefield.

Robert L. Hill is the Support Branch Chief, Robotics-Technology Insertion Activity, U.S. Army Engineer School.

Evaluating Robotics Systems

By Captain Robert Berg

The Engineer School has established the concept of employment evaluation (COEE) procedure as a means of developing analytical data to support fielding of unmanned ground vehicles. The COEE process is designed to offset a lack of operational information such as tactics, techniques, procedures (TTP), logistics, and safety requirements. In a COEE, the Robotics-Technology Insertion Activity (R-TIA) at Fort Leonard Wood conducts a series of well orchestrated combat scenarios. For example, in April 1994, soldiers at Fort Leonard Wood breached a route obstacle using an unmanned M60 chassis, called *Panther*. Data from the COEE exercise provided feedback to verify or modify TTPs and recommend technological changes to robotics hardware.

Two other COEEs with applications to operations other than war (OOTW) were conducted at the R-TIA facility in March and April 1994. To ensure a logical format for data generation, evaluation plans for both COEEs were written by the Test Evaluation and Coordination Office at Fort Leonard Wood. The first COEE was for a remote controlled land mine (RCLM), called *Hydra*. The second COEE was for a remote controlled, vehicle mounted, route mine detector developed for the Canadian Army, called *Jingoss*. Both COEEs required soldier participation in extensive field exercises.

The Hydra COEE

As the U.S. Army's involvement in contingency operations increases, the need for engineer units to perform nontraditional missions also increases. Peacekeeping and other noncombat missions place restrictions on line commanders. To safeguard civilians, the most common restriction limits the use of weapons and land mines solely to self-defense purposes, even though it is often difficult to tell innocent civilians from those participating with opposing factions.

While conventional land mines detonate on contact and do not distinguish between adversaries and innocent civilians, RCLM allow the commander to choose his target. The RCLM system Hydra, for example, allows the soldier or commander to identify a target through the use of an on-board, low-level light zoom camera.

The Hydra is a six-man system consisting of six mines and a command console, which is easily transported to high risk areas of operations. The six mines can be armed with an explosively formed penetrator, chemical canister, antipersonnel claymore-style mine, or other type of munitions. Each mine is individually emplaced by a soldier and linked by fiber-optic cable to a console that can monitor one or more "kill zones." The console has seven screens: one for each mine and one target screen, from which the operator controls detonation and movement. With this system, the operator has total control over who, what, and when the mines attack. Hydra has an additional feature that allows a string of electrically detonated explosives and/or blasting caps to be connected to one or several auxiliary ports. The system's camera can pan, tilt and zoom on any object the operator chooses. Thus, the operator can use the camera to assess a situation and destroy the target by detonating only one auxiliary port or he can detonate all six ports and the entire mine.

The COEE performed by R-TIA allowed engineers to evaluate Hydra's capabilities and study the tactics, techniques and procedures used to control the system. During the evaluation, soldiers were depicted in both mounted and dismounted operations in four scenarios: conducting an ambush, using Hydra as a protective minefield for an engineer combat service support unit, reinforcing a conventional minefield, and using the mine as a first generation intelligent minefield.

Scenario 1 involved a dismounted sapper squad, which carried the Hydra system to perform an ambush on opposing force (OPFOR) vehicles traveling along a secondary road. Using two of Hydra's mines as security, the sappers prepared the other four mines for use against OPFOR vehicles entering the kill zone. The security camera was placed about 1 kilometer away from the kill zone and provided video footage of oncoming vehicles. When the OPFOR vehicles approached, two soldiers conducted an ambush. One soldier monitored the target screen and fired a mine at the vehicle. The other soldier monitored the remaining six screens and directed which mine would be displayed next on the target screen.

In this scenario, two soldiers equipped with the Hydra system successfully performed an ambush. By employing robotics technology, the unit reduced the number of soldiers required to perform an ambush from an entire squad to two soldiers.

Scenario 2 was a two-phased training exercise in which nonengineer soldiers set up a hasty protective minefield for their unit. Soldiers assigned from a transportation company were trained by the Engineer School's sapper detachment for this exercise. Because the Hydra system is easy to operate, the soldiers quickly learned to use and maintain it. They used the auxiliary ports to control their M18 mines and used the camera to observe several high-speed avenues of approach. By employing Hydra, the transportation unit reduced the number of observation posts from eight to two, while providing the same level of security.

In ***Scenario 3***, an engineer squad from a corps mechanized battalion constructed a conventional minefield and used the Hydra system to overwatch and protect it. Hydra enabled the ground commander and engineer support element to protect the minefield and control any secondary charges such as demolition charges from the auxiliary ports. The Hydra's ability to individually fire each of the six auxiliary ports enabled the engineers to be active participants on the combined arms team.

In ***Scenario 4***, the Hydra was used without any conventional dummy mines. Each of its ports controlled demolition charges and/or electrically detonated mines. The Hydra afforded the commander

Photo opposite page: **Two sappers focus one of Hydra's six mines while preparing to ambush the OPFOR.**

Photo left: **A Canadian soldier controls the Argos and prepares to drive the vehicle into its trailer.**

Robotics System	Description	Subsystems	Missions	User
Hydra	Six remote-controlled land mines	- Antitank mine - Antipersonnel mine - Pan/tilt camera - Fiber-optic link - Six remote-demolition auxiliary ports	- Hasty protective minefield - Reinforce conventional minefield - Mine ambush - 1st generation intelligent minefield	Squad-level (light and mechanized) units.
Jingoss	Remote controlled, route mine detector	Remote controlled, 8-wheeled all-terrain vehicle with RF link to a control station in an armored personnel carrier - ARGOS - VMOD - ANCAEUS - Light Amphibious Vehicle (LAV) - Trailer	- Route clearing - Rear area operations	Squad-level units.

positive control over the demolition charges and each mine in the minefield, so that friendly units and civilians could safely pass through the minefield without tripping a fuze.

The Hydra COEE provided sufficient data to continue system evaluation. Plans are underway to include Hydra in future joint exercises with TRADOC Battle Labs. There is also a demonstrated need to continue development of the Hydra operational concept.

The Jingoss COEE

In response to a significant mine threat, the Canadian Army's Defence Research Establishment Suffield (DRES) has developed a remote controlled route mine detection system called *Jingoss*. The system has four major components: an eight-wheeled amphibious, all-terrain vehicle called *Argos*, which is used as a remote platform; an armored personnel carrier (APC); a metallic mine-detector head, called *Vehicle Mounted Ordnance Detector (VMOD)*; and a tele-operational controlled system called *Ancaeus* (see table).

The concept behind the Jingoss mine detection system is relatively simple. The Argos contains the receiver, vehicle control module, and actuators that control the vehicle. Additionally, it has two payloads. The first payload is a chain sweep, which is attached to the front of the Argos and sweeps the road for tilt-rod and tripwire mines. The second is the VMOD, which is pulled behind the Argos and detects metal objects. An APC follows from 100 to 150 meters behind the Argos, depending on the terrain, and carries a squad of sappers with hand-held mine detectors.

The Argos operator controls vehicle movement and functions from an APC by means of a 68030 Motorola computer processor. The computer uses video feedback from the Argos and, through a graphic user interface, superimposes a window environment control on the video screen. With this screen, the operator can monitor the Argos' status, see a graphic display, and hear an audio signal when targets are detected by VMOD. It also has map displays and a global positioning system (GPS) to confirm the Argos' location. The operator uses a joy stick or a keyboard to control the Argos. Additional features such as multivehicle control, autonomous control, and external cameras may be added to Jingoss.

Once in operation, the Argos travels from 3 to 5 kilometers per hour (kph). When the operator picks up a metal detection, the VMOD marks the location with marking fluid. The VMOD, which is four meters wide and one meter long, contains two detector heads. Each head is independent so that the operator can determine on which side of the road a detection is located. The marking fluid is placed on only one side, either left or right, when a mine-sized object is detected. A false detection, such as a culvert, would cause the VMOD to mark both sides. When a target is marked, the control vehicle stops and the four-man team use hand-held mine detectors to isolate the target and determine if it is a mine. Then they mark the mine and either bypass it or blow it in place, depending on the mission.

The Jingoss system can clear roads faster than a sapper squad can using hand-held mine detectors. A squad equipped with hand-held mine detectors can travel less than 1 kph, whereas the Jingoss can travel at speeds up to 5 kph.

The most frequently asked question regarding to the Argos-VMOD setup is "why does the Argos pull the detector head?" The logic behind this decision is based on the mechanics involved and the time allocated to constructing a bracket to mount the VMOD. The Canadians built the system from conception to final product in four months in order to respond to a peacekeeping mission in Somalia. A primary factor in selecting Argos was the system's ground pressure applied per square inch (PSI). Each wheel applies less than 150 PSI, which enables the vehicle to pass over a pressure-fuzed antitank mine without detonating it. This capability is critical because antitank mines are frequently encountered in their peacekeeping missions. Argos has no protection, however, against antipersonnel mines. Therefore, it is an expendable item which can be replaced by another Argos or repaired on site.

The Engineer School reviewed Jingoss' potential capabilities and invited the Canadian Army to display Jingoss during the 1994 Senior Engineer Leadership Training Conference. After the conference, R-TIA conducted a two-week COEE on Jingoss, with assistance from the Belvoir Research, Development and Engineering Center (BRDEC) and the Joint Projects Office for Unmanned Ground Vehicles/Systems (JPO).

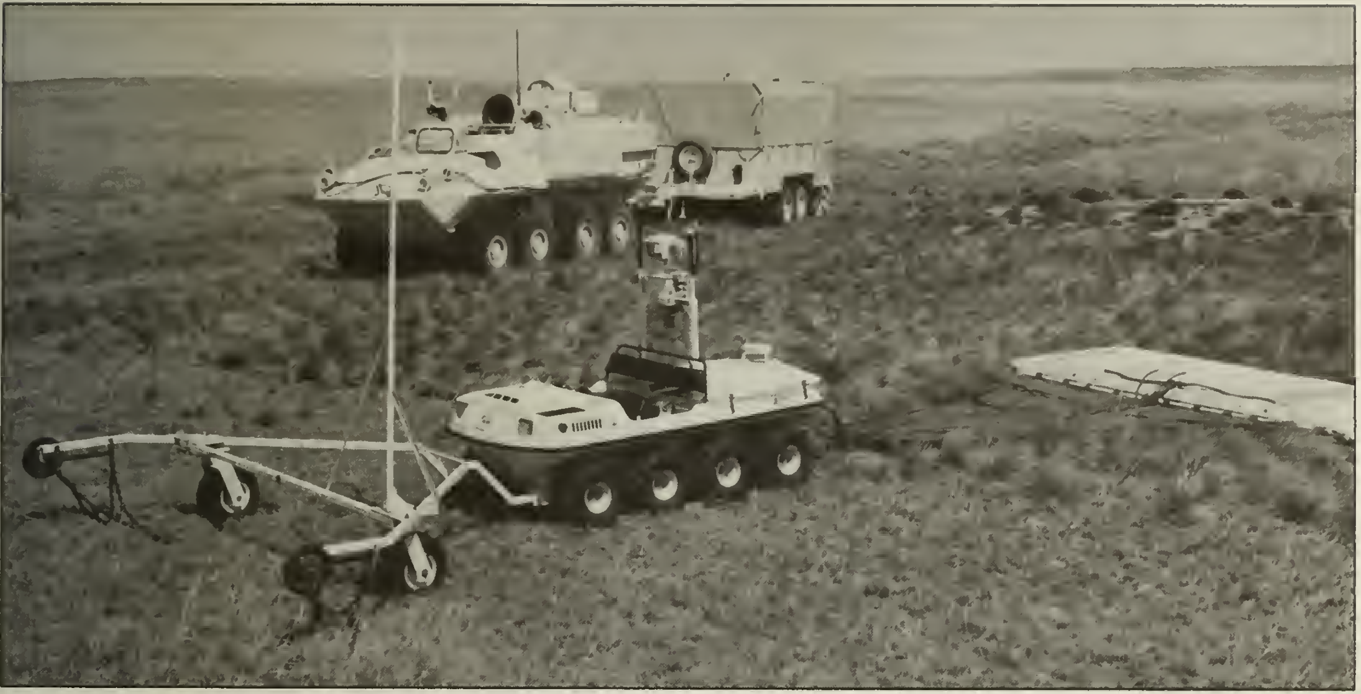


Photo courtesy Defence Research Establishment Suffield

A complete Jingoss system includes the Canadian Bison (LAV), with trailer, and the Argos, with a chain sweep and mine detector.

In the COEE, the Jingoss was employed in two scenarios: route mine detection and area mine detection. The evaluation concluded that the Jingoss performed well in route clearing missions but was not well suited for area clearing missions because it was difficult for the Argos operator to determine where he had or had not been. Although the system has some limitations, the Argos successfully detected large metallic mines buried as deep as 3 feet. The Jingoss is user friendly and easy to operate. As with hand-held mine detectors, however, Jingoss operators must practice to properly distinguish a mine from a false detection.

The Canadian Army plans to deploy the Jingoss system to Bosnia in the fall of 1994. In Bosnia, Canadian engineers will have an opportunity to test Jingoss' mine-detection capabilities in a real-world environment.

Future Applications

Evaluations planned by R-TIA for the near future will support engineer operations on the battlefield. For example, R-TIA will evaluate robotics systems capable of supporting MOUT operations, insert robotics technology in an M998 HMMWV for use in route-clearing operations, and evaluate concepts for employing unmanned breaching vehicles for use by a combined arms team. The R-TIA team will also evaluate the potential of the Mini-flail in clearing antipersonnel minefields, and evaluate an unmanned aerial vehicle for use by combat engineers in route clearing missions.

Because funding is insufficient to purchase robotics systems for the entire engineer force, the Engineer School has devised contingency kits and a new equipment training (NET) team and support package for units deploying to contingency operations. The kits are designed to enhance unit capabilities and ensure mission success.

For example, assume that C Company, 123rd Engineer Battalion is deploying with the 1st Brigade, 28th Armored Division, to North Africa. The unit anticipates a need for an unmanned vehicle to detect mines along supply routes. In such a situation, the Engineer School will give the unit a remote-control kit to insert in one of their vehicles. The NET team will train soldiers to operate the system and advise the commander of the best "text book" solution for employing the system. After two or three weeks of training, the unit signs for the system and the support package, and the NET team returns to the Engineer School. When the mission is completed, the unit returns the system to the Engineer School.

The robotics systems evaluated and fielded by R-TIA will enhance the ability of engineer units to accomplish contingency missions without unnecessarily risking soldiers' lives. The target date for the first contingency kit developed by the JPO is second quarter, FY95. The kit includes a package for an M923, 5-ton cargo truck and is designed to perform route clearing missions. A set of rollers will supplement the remote-controlled system. Because the kit is the first of its kind, it will be upgraded frequently with the latest technological advances. By using the COEE process, the R-TIA is working to help field unmanned ground vehicles for use by combat engineers in contingency operations.

Captain Berg is the operations officer for R-TIA at the Engineer School. Previous assignments include operations officer, V Corps Staff Engineers, tank company XO, brigade HHC XO, and tank and support platoon leader in Germany.

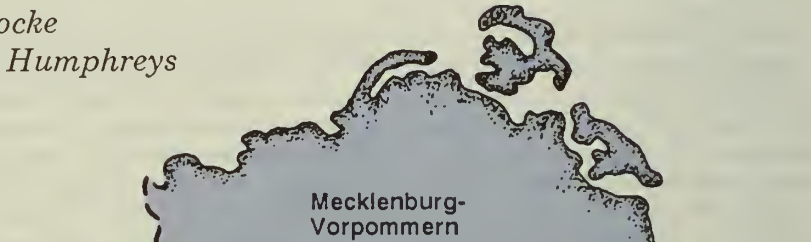
Demining Germany's Borders

By Lieutenant Colonel Reinhold Hocke
and Second Lieutenant Michael S. Humphreys

Cold war tensions left nearly 1,500 kilometers (km) of barriers along the inner-German border (IGB) separating East and West Germany and along the East German border of West Berlin. In addition to the extensive barrier system constructed between 1961 and 1985, the former German Democratic Republic (GDR) emplaced at least 1.3 million antipersonnel (AP) mines of various types and generations along the IGB. These obstacles were not designed to protect against western invasion but to prevent the defection of East German people to the west. After reunification in 1990, Germany launched a concerted effort to dismantle the barriers, demine the former border areas, and dissolve any remnants of its once torn countryside.

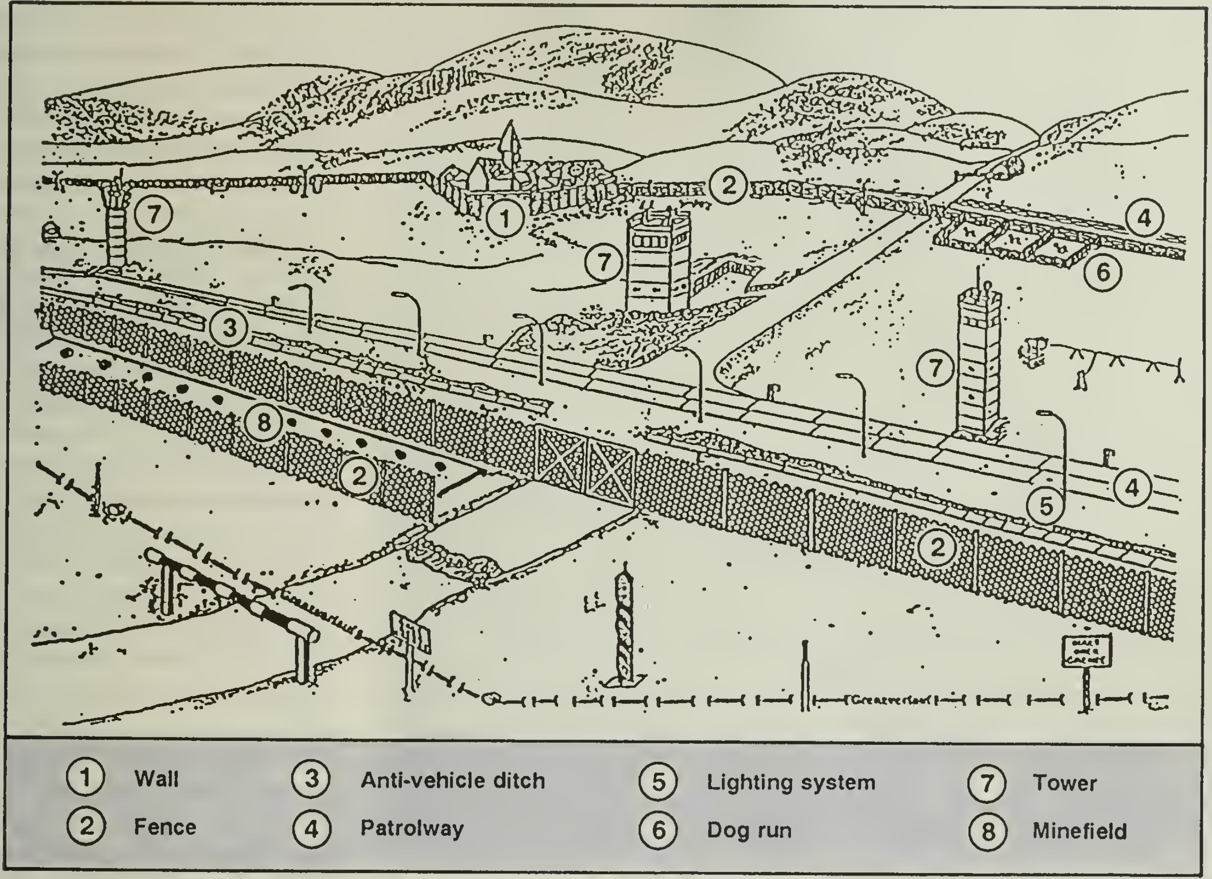
Cold War Legacy

In 1984, mounting international pressure forced the GDR to begin clearing its



Barrier areas along the former Inner German borders — — —

Barrier system along the former inner German border (IGB)



minefields. By then, a signal and barrier system, consisting of a series of sensor-equipped fences and runs where trained dogs could patrol the border, had reached a state of efficiency that rendered the mines unnecessary (see figure). A year later the GDR reported that their border troops had cleared the minefields and neutralized all AP mines buried along the IGB.

After reunification, the Federal Armed Forces of Germany established the central deactivation staff of border troops, now headed by an army engineer officer. The staff reviewed existing documents from the GDR's mine-clearing operations and found some discrepancies. Additionally, engineer officers of the former border troops reported that the GDR's clearing operations had been inadequate because they had continuously operated under strict time constraints.

Speculation about the lingering mine hazard led to an investigation of the questionable areas in 1991. Analysis of the GDR's mine plans and sweeping records revealed significant discrepancies between the number of mines laid and the number detected or detonated during their clearing operations. Records showed a total shortage of 34,000 mines. Although many of those so-called "deficient mines" may have been detonated by outside influences such as animals or frost, a danger of intact mines lying in the border sectors remained.

The commanders of the former GDR border troops had accepted the discrepancies because the East German government's objective had been to convince the outside world that the mines had been removed, and internally to provide safe conditions to construct a modern signal and barrier system. The GDR never intended to open the border sectors, and their border troops could work safely along the IGB after being warned about the hazardous areas.

Barrier Removal

The plans of unified Germany to mend the gash that separated East and West Germany and dissolve the border areas back into the German countryside would not be accomplished easily. To eliminate the remaining mine hazard, Germany's Minister of Defense decided that minefields once thought to be cleared by the GDR's border troops would again be searched.

Although the mine hazard loomed like a ghost from a by-gone war, the most obvious presence along the IGB was the barrier system that had been erected to keep

Photo courtesy Colonel Gerhard Rueddenklau

An observation tower on the IGB is removed as part of the cleanup process.

East German citizens locked behind the Iron Curtain. Before minesweeping equipment could be used to clear the suspected mine hazard, it was necessary for Germany to dismantle those barriers. Heavy earth-moving equipment was brought in to remove the obstructions, and that part of the operation was finally completed in January 1994. The number and types of barriers cleared in this effort are shown in Table 1.

While barriers were still being removed in some border areas, mine clearing operations began. Although the actual work is conducted by government contracted civilians, the German Army Corps of Engineers supervises the operation.

It is Germany's intent to eliminate all hazards that might still exist in areas formerly laced with mines. Sectors where a comparison between mine-laying plans and clearing records show discrepancies are classified as "mine hazard areas" and marked with danger signs. The German government estimated the original length of the mine hazard areas to be 555 km. The types of mines emplaced along the IGB are shown in Table 2, page 17.

Restoring safety in terrain sectors formerly littered by mines means more than simply clearing known minefields. When a minefield is first emplaced, fixed orientation points from which the minefield is measured are placed and recorded. When the GDR first reported their minefields were cleared in 1985, they removed the orientation points. Without those points, it would be almost impossible for clearing teams to accurately locate the minefield perimeters. Therefore, the German government has entrusted mine clearing to government contractors, who employ former border troops of the GDR. These civilians are most familiar with the areas where the GDR had

Number of Barriers Removed in Germany

Types of Barriers	Unit	Location		Total
		IGB	Berlin	
Walls	km	31.83	178.63	210.46
Fences	km	2564.48	297.07	2861.55
Concrete reinforced anti-vehicle ditches	km	638.50	84.99	723.49
Unreinforced anti-vehicle ditches	km	51.78	—	51.78
Patrolways	km	559.66	119.39	679.05
Lighting system	km	237.31	160.13	397.44
Flood lights	km	91.60	—	91.60
Dog runs	km	170.20	6.60	176.80
Wire obstacles	km	86.25	8.00	94.25
Towers	each	538	255	793
Bunkers	each	48	—	48
Bridges	each	89	12	101
Underwater obstacles	each	168	7	175

Table 1

planted mines and are best qualified to ensure all mines are detected. In addition to searching areas once saturated with GDR mines, the detection teams also search for mines that may have been washed to lower ground by heavy rains or mud slides.

Mines Emplaced Along Former IGB		
Type	*Origin*	*Years Emplaced*
POMS-2	USSR	1961 - 70
POMS-2M	USSR	unknown
PMD-6M	USSR	1962 - 79
PMN	USSR Bulgaria	1963 - 85
PMP-71	GDR	1971 - 85
PPM-2	GDR	1971 - 85

Table 2

Clearing Methods

When clearing a suspect area, the mine detection team first conducts terrain reconnaissance to verify the results of document review. The inspection party, with the participation of civilian authorities if required or requested, then decides on the type and scope of the mine-detecting operation. For example, their efforts may include restrictions to conserve natural resources or protect the environment.

After the reconnaissance, the teams prepare the terrain for mine detection. Today this usually means cutting plants and trees, but before 1993 it also included the dismantling of barrier fences. Because the work is extremely hazardous, the teams must wear protective clothing and work from ramps. These restrictions make the job an arduous undertaking, especially in summer.

Although the methods now used to clear mined areas are similar to those used by the GDR in the 1970s and 1980s, the procedures are more successful because teams are not required to work under tight deadlines. The objective of current mine-clearing operations is to be thorough not fast. Based on experience and severe personnel losses (130 soldiers injured from 1962 through 1984), the former GDR border troops developed two major mine-clearing procedures: tillage and probing.

Tillage

Tillage, a mechanical mine-detection method, is the technique preferred by the clearing teams. It consists of treating a suspect area four times with a double-shared plow and harrow towed by a tractor. Metal plates and steal mesh on the tractor protect the driver. Plowing brings the mines up to the surface, where they can be seen. Usually the soil is plowed to a depth of 30 centimeters (12 inches), but in unusually wet or

A German civilian with an excavator tears down a fence along the IGB. The contractor employs machinery and construction equipment formerly used by East German border troops.

Photo courtesy Colonel Gerhard Rueddenklau

Photo courtesy Colonel Gerhard Rueddenklau

An inspection team looks for mines from a dozer equipped with a front-mounted platform. The protective clothing has been developed especially for personnel working in mine detection and mine-clearing operations.

marshy soil, the teams may plow as deep as 80 cm (32 inches).

The GDR-emplaced minefields have a standard width of 180 meters and a standard depth of 23 meters. To treat a minefield, a team plows 20 meters beyond each side in width and 5 meters beyond each side in depth. After the tractor begins to plow a lane, the team inspects the ground in two ways: first by observation from the tractor towing the plow, and then by minesweepers who follow on a working platform mounted on the front of a bulldozer (photo).

If a mine is detected, explosive ordnance disposal (EOD) teams destroy it by demolition. Then the team begins the tillage operation over again and continues until no more mines are found in any of the four tillage treatments.

Visual inspections by the teams do not always result in the discovery of whole mines. However, in all cases the mine detection teams will find parts of mines if the tillage is conducted on a minefield site and along the lines where the mines were laid. Visual inspections are essential to ensure that no suspected minefields are missed.

Safety is an extremely important part of the mine-detection and disposal operation. It is especially critical when teams clear areas using the tillage method. *Tillage is feasible because the GDR emplaced only antipersonnel mines (no antitank mines) in the border areas.* Efficiency standards for the tillage method cannot be specified, however, because the number of treatments required to completely clear a sector of all mines cannot be assessed.

Probing

Wherever the terrain or soil conditions make plowing impossible or where metal case fragmentation mines were emplaced, the teams must use a probing method to clear minefields. Probing is a manual method of detecting mines. It consists of searching the suspect area with an electronic mine detector. The German teams use the Schiebel AN/PSS-12 detector, which is also employed by U.S. Army engineers. It emits a signal when it encounters metal objects. When the signal is activated, a team member uses a long, slender, nonmetallic probe to confirm the source. The worker gently pushes the probe into the ground at an angle less than 45 degrees so that it will not accidentally detonate a pressure fuze. After the location is confirmed, a team member removes dirt around the object to determine if it is a mine. When a mine is located, EOD teams either remove it or destroy it in place.

All mines do not have metal casings, but the Schiebel detector can locate the metal components found in most low metallic mines. Because teams must individually inspect and clear each signal, the probing method is a time-consuming and labor-intensive procedure. Therefore, the teams use the tillage method whenever possible.

Logistical Support

At the end of a successful mine clearing operation in a sector, the contractor, in cooperation with a representative of the German Corps of Engineers, turn the cleared site over to the German government. Other logistical efforts include medical support in accordance with the demolition regulations of the Bundeswehr (German Army) and equipment maintenance. For example, when teams handle munitions or live demolitions, a medical unit with emergency equipment must be available at the site.

The major factor limiting the speed of Germany's mine-clearing operations is the number of qualified teams available to do the work. At first, work teams were involved with both removing obstacles and clearing mines. After the border fortifications were dismantled, however, the German contractors involved in clearing the IGB consolidated and reorganized to focus primarily on mine detection. As a result of this reorganization, the number of mine-detection teams increased from nine in 1993 to 14 in 1994. The number of workers on each team varies, based on the location of the site and the detection method used. The additional five teams brought the total number of workers involved in mine detection and clearing to 270.

The additional detection teams and reclassification of some areas from hazardous to nonhazardous mean that the process of detecting and clearing potential mine hazards will accelerate. Of the original 555 km of terrain classified as hazardous in 1991, approximately 361 km were laced exclusively with PMD-6, wooden-box type mines. These mines were fully functional when first buried in the 1960s, but during the 30 years they were in the ground the fuzes and wooden boxes deteriorated. Today, only weathered pieces of wood, lumps of explosives and heavily corroded fuzes and fuze components can be detected. Detailed investigation of excavated components revealed that these mines no longer present any danger. In August 1992, the Minister of Defense decided not to extend efforts to detect the wooden-box, pressure-blast mines.

"It is Germany's intent to eliminate all hazards that might still exist in areas formerly laced with mines."

The decision to disregard the wooden-box mines reduced Germany's overall mine hazard area to 194 km. This area contained both metallic and nonmetallic, blast-type mines, of which approximately 16,000 were not recorded by the GDR.

The terrain reconnaissance performed before the teams began mine-clearing operations have disclosed that 21 km of terrain reportedly cleared by the GDR are free of mines. These areas have been used extensively for agricultural purposes for more than 10 years and are no longer considered hazardous. Elimination of these areas reduced the total remaining mine-hazard areas to 173 km.

The Last Obstacle

All sectors for which an evaluation of available minefield records did not reveal the existence of discrepancies, or which did not contain any other information suggesting the presence of mines, were initially declared as nonhazardous. The political branch of the Ministry of Defense agreed to assume responsibility for any residual risk in these areas. Many mines have been detected in these sectors within the last 3 years, however, and they have been reclassified as hazardous, adding 29 km to the operational area.

As of 30 April 1994, the overall hazardous area was 202 km in length. Of this area, about 130 km of minefields have been cleared. The clearing teams found a total of 714 AP mines, which equates to about five mines per kilometer. Average clearing costs amounted to DM 150,000 per kilometer, or about DM 30,000 ($20,000) per mine. Terrain sectors with a total length of 72 km remain to be detected, with clearing operations expected to be complete by the end of 1995. By then, the German Corps of Engineers and the Ministry of Defense are confident that the mine hazard along the former IGB will be eliminated and the area will be safe for use by German citizens.

The authors gratefully acknowledge the assistance of Colonel Gerhard Rueddenklau, German Army Corps of Engineers, who contributed the photographs and data regarding Germany's border-clearing operations.

Lieutenant Colonel Hocke serves as German liaison officer to the U.S. Army Engineer School and Center, Fort Leonard Wood. He previously served as commander of the German 61st Engineer Battalion, 6th Armored Infantry Division, staff officer engineer and senior combat engineer officer, Headquarters Allied Forces Central Europe. LTC Hocke is a graduate of the German General Staff Officers Course at the Federal Armed Forces Command and General Staff College, in Hamburg.

Second Lieutenant Humphreys is currently enrolled in the Engineer Officers Basic Course at Fort Leonard Wood. He is a veteran of the Gulf War, where he was enlisted in the Corps of Engineers. Lt. Humphreys is a graduate of the Airborne School and holds a bachelor of science from East Tennessee State University, *The U.S. Army Engineer School continues to receive questions and comments concerning the capabilities and employment techniques of the AN/PSS-12 Hand-Held Mine Detector, also called the AN19/2 Mine Detector. The following articles describe the mine detector's capabilities, recommended training techniques, and the operational experiences of organizations that have used the detector in demining operations.*

The AN/PSS-12 Mine Detector: *A Proven Performer*

By Phil Purdy

The AN/PSS-12 Hand-Held Metallic Mine Detector has been in service with U.S. Army units since April 1992. Several articles have been published concerning the selection and fielding of the AN/PSS-12; this article focuses on its performance and soldier confidence.

The AN/PSS-12 replaces the Army's aging and obsolete AN/PSS-11 mine detector. Fielding of approximately 15,000 of the new detectors began in April 1992 and will be completed in mid-1995. As of June 1994, it has been fielded to most authorized Active Component units within the United States, Europe, Pacific, and Korea. Fielding to authorized Reserve Components units will be completed in mid-1995.

The name "AN/PSS-12" is the U.S. Army's designation for the Schiebel AN19/2 detector, which is manufactured in Austria. Before selecting the AN/PSS-12, the Army competitively evaluated it against eight other leading manufactures' metallic mine detectors. Selection criteria included equipment performance, ease of use, and overall "best value."

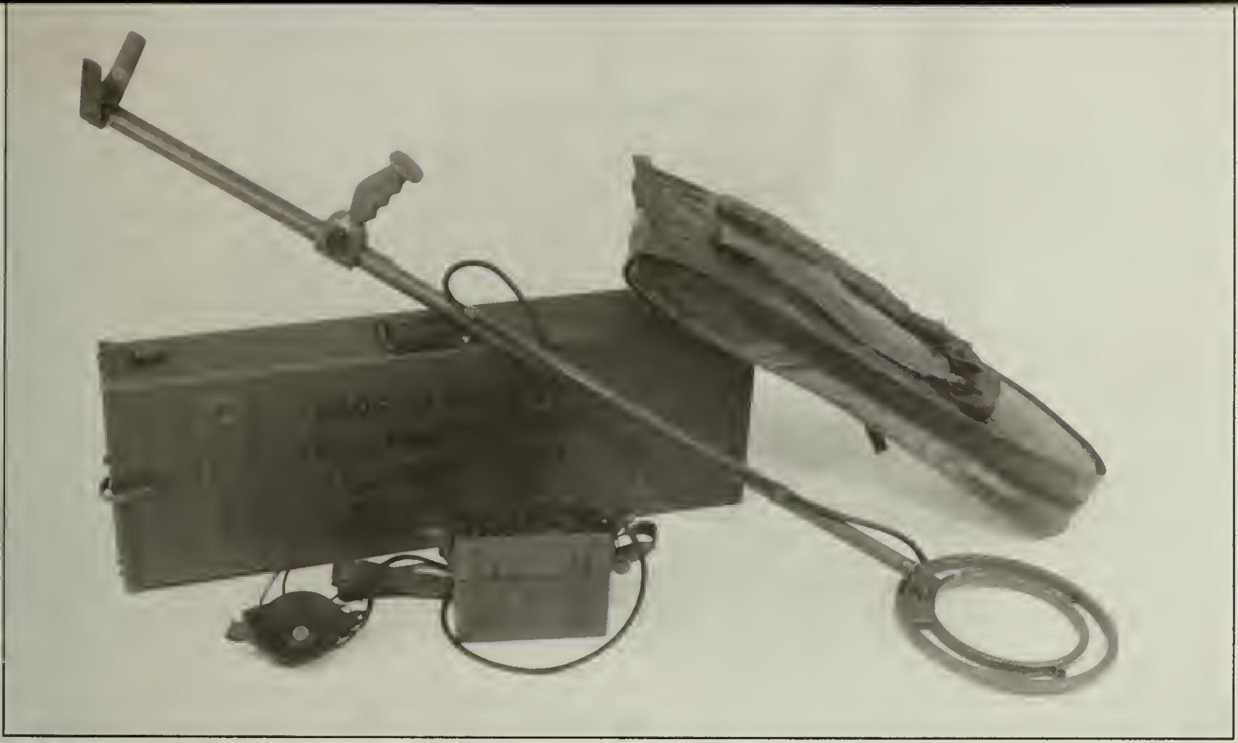
Performance

The U.S. Army documented the AN/PSS-12's performance during technical and operational testing in 1991. These tests clearly demonstrated the equipment's excellent detection capability, ease of use, and reliability. Technical testing was conducted by the Belvoir Research, Development and Engineering Center, Fort Belvoir, Virginia. Operational testing was conducted by the Army Test and Experimentation Command at Fort Hunter Ligget, California, and at Fort Leonard Wood, Missouri.

How well does the AN/PSS-12 perform in tactical and real-life mine-clearing operations? While

Photo by SPC Virginia Espree

SPC House operates the light-weight and user-friendly AN/PSS-12 mine detector. As the search head is swept over the ground, an audio signal indicates the presence of a possible mine.



Major components of the AN/PSS-12 mine detector set include a search head, telescopic handle, control box, and headphones. The mine detector uses standard D-cell batteries.

it is a metallic mine detector, the AN/PSS-12 has the sensitivity and capability to detect minute amounts of metal (one-fifth of a gram). Therefore, it can detect most low metallic (sometimes called "nonmetallic") mines because most of them have some metal in their fuze or detonation device.

So far, use of the detectors by U.S. Army soldiers has been limited to routine training and units assigned to support Operation Restore Hope, in Somalia. Because the U.S. Army's experience with the detector is limited, the best assessment of its performance probably is through the experiences of other countries, humanitarian agencies, and commercial demining companies.

The Schiebel AN19/2 is used by several U.S. allies and friendly nations, including Canada, the United Kingdom, the Netherlands, Sweden, and several nations in the Persian Gulf. Organizations such as the United Nations (UN) and International Red Cross use the Schiebel AN19/2 in extensive demining operations around the world. The UN currently uses it for demining operations in Cambodia, Afghanistan, Somalia, and Mozambique. Based on their experience, UN personnel report that the AN19/2 is reliable and performs well. Brigadier General P.M. Blagden, retired from the United Kingdom and currently at the UN, reports favorably on the detector. He states that Royal Ordnance Plc, the commercial company that successfully cleared the UK sector of Kuwait after the Gulf War, used the Schiebel AN19/2 there in preference to other detectors, although at least three types were available.

The Canadian Army has used the Schiebel AN19/2 since 1988. As a participant in several UN peacekeeping missions, the Canadian Army has acquired considerable experience with the detector. Canadian peacekeepers have used it in the former Yugoslavia since April 1992 and report that the AN19/2 can detect the low metallic mines currently in use by the opposing forces. They have experienced few maintenance problems and consider the AN19/2 to be one of the best metallic mine detectors on the market today. (See article, page 29.)

Commercial Munitions Systems International (CMSI) successfully cleared more than 338,000 metallic and low metallic mines in the U.S. sector of Kuwait using the AN/PSS-12 mine detector. When selecting a detector for that operation, CMSI chose the AN/PSS-12 based on such critical performance factors as reliability, capability, and low maintenance requirements. (See article, page 25).

Soldier Confidence

U.S. soldiers can be confident that the newly fielded AN/PSS-12 will meet their mine-detection requirements. Effective training, however, is critical to maximum performance of the detector and soldier confidence. While the equipment is easy to operate, proficient mine detection requires repeated practice against known threat targets. Only through practice will soldiers hone the skills they need to successfully detect mines with low metal content. With proper training, the AN/PSS-12 is one of the most effective mine detectors in the world.

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Photo by Richard Cassell, courtesy CMS, Inc.

Operating a Mine Detector:

Proficiency Through Practice

By Captain James E. Berhow, USMC

Information received at the U.S. Army Engineer School and published in the November 1993 issue of *ENGINEER* (page 5) indicates a lack of confidence in some engineer soldiers' ability to successfully locate buried antipersonnel or antitank mines using the AN/PSS-12 mine detector. I do not believe this to be a true representation of the U.S. Army as a whole. This article describes several measures combat engineers and their leaders can take to improve operator proficiency or skill-level with this equipment. First, let's clear up a few misunderstandings regarding the AN/PSS-12 mine detector.

Background

The U.S. Army selected the Schiebel AN/PSS-12 mine detector as a nondevelopmental item over several other "finalists" more than two years ago. Without doubt, the Army purchased and placed the best available mine detector in its inventory. This was confirmed by a private agency, Commercial Munitions Systems International (CMSI), when their employees logged more than 25,000 hours using the AN/PSS-12 in their successful demining operation in Kuwait. (See article, p. 25) Although CMSI could have selected any detector, they chose the Schiebel. The U.S. Marine Corps has also placed this mine detector into service in its engineer units. Additionally, many countries have purchased the Schiebel mine detector for their armies, including Austria, Canada, Germany, Sweden and Thailand. The bottom line is that the AN/PSS-12 is a very good mine detector!

The U.S. Army Engineer School trains more than 8,000 engineer soldiers, noncommissioned officers and officers annually in the area of combat engineering. Only a limited segment of each course syllabus, however, is devoted to mine warfare. For military occupational specialty (MOS) 12B10 soldiers, this equates to three days out of a five-week course, and only three hours of that are spent on the mine detector. During those three hours soldiers study equipment characteristics, operational set-up and use, and preventative maintenance. Resident training at the Engineer School, therefore, does not produce proficient mine detector operators.

Operator proficiency is acquired by the individual soldier at his parent unit, and responsibility for that training rests with unit leaders. A skilled operator can detect virtually any known mine with the AN/PSS-12 mine detector, but it takes a lot of practice to reach that level of proficiency. There is no set rule of thumb that says a soldier must train for a certain number of hours to become a "journeyman" mine detector operator. Each soldier will require a different amount of time to become familiar with the equipment and learn how it interacts with his senses of sight, sound and touch. As an operator's proficiency increases, so does his confidence.

Confidence is almost as important as skill. That's because a skittish or nervous soldier in the minefield can be as dangerous as an ignorant or untrained one.

Training Tips

Unit training is the key to acquiring operational skill with the mine detector. To assist in developing unit training, the U.S. Army Engineer Center has developed the following tips for combat engineers and their leaders:

- The mine detector search head must remain parallel to the ground and at a consistent distance from the ground to operate correctly. Never drag the search head along the ground because contact may cause pressure-activated mines, sensitized cluster bomblets or submunitions to detonate. Dragging the detector along the ground also causes unnecessary wear on the search head's plastic casing.
- Most operators have a tendency to raise the search head at the end of a sweep arc and must concentrate to keep it level. Be aware that any change in the position of the search head changes the way the mine detector reacts to buried metal.
- The mine detector search head must move through a constant 1-meter radius arc (2-meter frontage). The operator must develop a smooth, uniform sweep or he may miss mines as he moves forward.
- The sweep speed of the detector search head must remain constant. Operators who sweep too quickly may miss mines with a low metallic content.
- The rate of forward motion must remain constant. Operators have a tendency to vary their sweep speed and forward motion as they tire or get bored. Rate changes will result in the area being improperly swept.
- When using the mine detector, operators must ensure that obstacles such as rock outcroppings, trees, and debris do not alter the sweep pattern. Obstacles will affect a sweep pattern and may cause mines in the sweep path to be missed. A common error occurs when a low obstacle is encountered. Operators frequently raise the search head an inch or two to clear the obstacle and keep a constant sweep rate. Raising the search head alters the sweep pattern and may cause the operator to miss a mine.
- When physical discomfort exists, operators have a tendency to focus their attention away from the mine-clearing mission. Any time an operator is uncomfortable, he should stop and

Photo by CAPT Berhow

Training mines that duplicate the size, color, and appearance of threat mines can be requisitioned from local Training Support Centers (TSC). For detection purposes, however, these molded or demilitarized mines may not accurately reflect the precise metal content of the real mines.

Photo by CAPT Berhow

Units deploying to a known region of the world can construct pens or boxes that replicate the soil composition in that area. Use of these pens facilitates countermine training.

take the time needed to readjust the equipment or relax his muscles.

The following suggestions may also increase operator proficiency with the AN/PSS-12 mine detector:

- To reduce boredom or complacency, rotate the detector operator in the sweep team every 30 minutes.
- Before starting any mine-detection operation, ensure all equipment operators take a short detection-capability test. This test will ensure every soldier can operate the detector at minimum acceptable standards and does not have a sinus, nasal congestion, or other physical condition that may inhibit his ability to hear the electronic signal.
- Units deploying to a known region of the world can find out what types of mines they can expect to encounter in theater. When training for such a deployment, unit trainers should "qualify" their soldiers in the probing techniques and detection methods required for those specific mines. To train properly, they should construct training pens or boxes that replicate the region's soil composition and requisition the specific mines needed to practice with. The mine-clearing qualification should be similar to the engineer soldiers' annual update for the weapons range and NBC training.
- After a specific sensitivity has been set on the detector, slide a metal object such as a 16-penny nail along the shaft toward the search head element, and mark the exact spot where the detector sounds off. Use the mark as a reference point when performing calibration checks to verify that the detector's sensitivity setting remains constant. To ensure accuracy, use the same nail in all calibration checks.
- A unit deploying for a mine-clearing mission may obtain specific information or request a mobile training team from the Engineer School to assist with their predeployment mine/countermine preparation. To request information or assistance from a mobile training team, write to: Commandant, U.S. Army Engineer School, ATTN: ATSE-T-CE-D, Fort Leonard Wood, MO 65473. Or, call (314) 563-4134, DSN 676-4134.

Operator Proficiency

The process of mine-detector training and operator proficiency does not end at the Engineer School or at the unit. It is an ongoing, continuing process that must be continually maintained. The new AN/PSS-12 mine detector is an excellent tool. To use it effectively, the individual soldier must be committed to practicing this craft; at the same time, his leaders must ensure that sufficient training time is allocated for this purpose. Units that train effectively will benefit by enlisting themselves with confident operators who are sure of themselves and the AN/PSS-12 mine detector in their hands.

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LESSONS LEARNED

Kuwaiti Demining Operations

By Captain Lawrence M. Chirio

The United Nations estimates that there are now more than 105 million uncleared land mines spread throughout 62 countries. This equates to approximately one land mine for every 50 people on our planet. These mines directly threaten civilian populations: Worldwide estimates for those killed and injured range from 10,000 to 100,000 people annually, most of them innocent women and children. U.S. military forces will probably encounter various types of land mines during any future combat operation or operation other than war, regardless of the location.

ISSUE: Demining operations involve the removal or recovery of land mines in a non-hostile, permissive environment. While current U.S. Army doctrine does not support demining operations, such operations have been conducted or are ongoing in Cambodia, El Salvador, Nicaragua, and the former Yugoslavia. As engineers, our job is to breach and mark cleared lanes on a battlefield and move on. Times change, however, and so do our missions. Because of operational necessity, some U.S. Army engineer units may be faced with the extremely difficult task of demining large areas in the future.

This article focuses on lessons learned during demining operations conducted by Commercial Munitions Systems International (CMSI), a civilian contractor, in the U.S. sector of Kuwait. The techniques used by CMSI personnel enabled them to successfully clear more than 338,000 mines (approximately 40 percent of them buried) and several hundred tons of unexploded ordnance (UXO). The lessons from this operation may help other engineers successfully perform demining missions in the future.

WARNING

The following information describes techniques that are NOT in accordance with Army doctrine. Before employing any of these techniques, field units must request approval from the U.S. Army Engineer School Commandant. The methods described were used by Commercial Munitions Systems International personnel and achieved successful results in Kuwait. Some of them are unique to the Kuwaiti environment and may not be applicable in other environments. If your unit is tasked to conduct demining operations, immediately call the U.S. Army Engineer School at (314) 563-4007 for assistance.

DISCUSSION: The U.S. Army Engineer School recently received a letter from Floyd D. Rockwell, who was employed by CMSI after the Persian Gulf War. His letter was an after action report that described their operation to clear all land mines and UXO in the U.S. sector of Kuwait. While working for CMSI, Mr. Rockwell served first as a consultant and later as the minefield zone manager, responsible for clearing the entire U.S. sector.

The AN/PSS-12 Mine Detector

During their demining operation, CMSI personnel logged more than 38,000 hours using the AN/PSS-12 Mine Detector. While they found it to be a very effective and reliable piece of equipment, CMSI personnel modified some of the procedures described in the AN/PSS-12 Mine Detector User's Manual. Additionally, Mr. Rockwell developed some techniques that significantly enhanced the crews' ability to detect mines with minute (one-fifth of a gram) metal content. Such mines are sometimes called "nonmetallic" but really are "low metallic."

The CMSI employees established an initial sensitivity setting and conducted field sensitivity checks in a sterile area that contained several of the type of low metallic mines they expected to clear that day. These mines were buried 6 inches beneath the surface. The crews checked their detectors and set the initial sensitivity level for tonal "beep" changes. While in the sterile area the teams also conducted field sensitivity checks by using a large mason trowel with the detector. Their method follows:

▶ Paint one cable clip on the detector a bright color so it is easily identified. Place it between the two unpainted clips on the detector.

▶ Attach all the clips to the lower extension of the mine detector's handle.

▶ Use the blade of the trowel to move the cable clip down the handle until the detector picks up the metal blade and begins to "growl."

▶ Run the blade of the trowel past the painted cable clip after every two sweeps with the detector to verify that the sensitivity has not changed. Adjust the sensitivity level setting as needed.

Mr. Rockwell believes that the operator must perform field sensitivity checks at regular intervals (i.e., every several sweeps), although no guides for these checks are provided in the user's manual.

The CMSI crews found the above method of sensitivity calibration to be very useful when they encountered a metal mine or large metal object. When they found one of those items, the crew turned down the detector's sensitivity so they could locate the center of mass. After a mine was located and neutralized, they reset the detector to its initial sensitivity level, performed another field sensitivity check, adjusted the detector, and resumed sweeping the area.

Early in the Kuwaiti demining operation, the AN/PSS-12 became sensitive to heat. The detector began to lose sensitivity at 110° F ground temperature and continued to lose sensitivity as the temperature rose. The CMSI crews compensated for the loss by increasing the detector's sensitivity setting. To ensure maximum equipment reliability, they also rotated the detectors every 30 minutes after the ground temperature reached 110° F. The crews stopped working when the ground temperature reached 130° F because they could not continue to safely concentrate on the clearing operation.

Soil type and conditions also affected the mine detector's sensitivity level. For example, wet sand would stick to the detector head and cause it to become less sensitive. CMSI personnel solved that problem by fabricating a cover for the detector head. The cover kept sand from sticking to the head and prevented any loss in sensitivity. The detector also "sounded off" when it came in contact with soil burned by oil well fires, erroneously indicating that metal was beneath the surface. After the soil crust was broken, however, the detector returned to a normal reading. This condition was Kuwaiti-specific and could not be duplicated outside the country.

The AN/PSS-12 mine detector can locate low metallic mines buried as deep as 6 inches beneath the surface. The user's manual states that operators should "maintain clearance of at least 2 inches above the surface." The clearing crews could not detect a low metallic mine that was actually buried 6 inches deep, if they maintained the 2-inch clearance. Therefore, CMSI operators skimmed the ground with the head of the detector, allowing the equipment to detect low metallic mines at the maximum depth possible. Initial concerns that personnel might accidently hit trip wires as the head skimmed the surface dissipated when the crews quickly learned that the detector located the trip wires before they were encountered.

The CMSI crews found that rechargeable batteries were ineffective and should not be used in the AN/PSS-12 mine detector. Rechargeable batteries reach a drop-off point as they lose power, and the low-battery light may fail to activate. As a result, the detector will quit without warning. Operators can avoid this problem by using only the batteries authorized by the manufacturer, such as the BA-30 or D-cell alkaline batteries.

Demining Training

One area Mr. Rockwell stressed was training and confidence building. Personnel had to feel confident in the equipment and procedures they were using in order to work effectively day in and day out. Because of their training program, CMSI had only two accidents and one death in 18 months, compared to 83 deaths not counting injuries from the other five coalition teams during the same period. He attributes their favorable safety record to strict procedures and confident personnel.

If an accident occurred, an investigation began immediately to find the cause. Investigation results were disseminated quickly to all personnel to maintain confidence in equipment, training and safety procedures. Published results of the accidents involving CMSI personnel showed no actual equipment failures. Their accidents occurred when two employees violated the strict safety procedures.

All CMSI personnel were certified only after completing a two-week training course, regardless of their previous experience. The course included detection techniques, disarm procedures, down-man drills, and first aid. After certification, all personnel were required to attend monthly refresher courses.

All CMSI personnel were trained using inert mines that had the exact metal content and configuration of those found in Kuwait. This training built confidence in the operators' ability to detect mines with the AN/PSS-12 and confirmed that the equipment could detect low metallic mines. They trained and operated in three-man teams and rotated jobs at least every 30 minutes. The teams consisted of:

- A **minesweeper**, who operated the detector and located and disarmed mines.
- A **safety observer**, who watched the minesweeper, looked for signs of fatigue, ensured strict adherence to procedures, maintained communication with personnel outside the minefield, made all safety decisions while in the minefield, and marked a clear lane to ensure rapid recovery in case an accident occurred.
- A **man on break**, who remained outside the minefield and had no designated duties except to rest and relax.

Once established, the teams did not change members or alter their rotation sequence except when absolutely necessary. This procedure enabled the teams to establish strong working relationships and close bonds between members. If one team member was ill, the remaining two worked on a one-hour shift. They rotated jobs every 30 minutes and then took a 30-minute break.

Demining Operations

To ensure safe demining operations, CMSI established the following procedures:

- Before starting operations, Mr. Rockwell personally conducted what he called "exploratory breaches." These breaches were conducted every 500 meters over the entire width of the minefield to verify mine distribution patterns, mine types, depth of buried mines, environmental hazards, and the percent of "frag" (i.e. metal fragments, submunitions, unexploded shells, etc.).
- The CMSI teams used the "blow in place" method of mine removal only as a last resort. Their rationale was that blowing mines in place raised the percentage of fragments in a minefield and increased the difficulty of detecting any remaining mines.
- Mr. Rockwell experimented with the .50 caliber Barret Rifle using ball and tracer rounds because Rufus high-explosive rounds were not available. He found the rifle to be ineffective for clearing large areas. If a mine didn't detonate fully after being hit, it created a major disposal problem by increasing the frag content of the minefield.
- The CMSI teams "swept" every hole with the AN/PSS-12 detector after a mine was removed. This additional safety check would determine if mines were stacked on top of each other. These mines were called "suckers." Often as many as three mines were found stacked up with a layer of soil between them.
- Large, mason trowels made excellent tools for probing and excavating mines in Kuwait's sandy soil. The CMSI personnel used the trowels only after they had completed an exploratory breach and found no magnetically fuzed mines in the minefield.
- Mr. Rockwell elected to attach the mine detector's headphone directly to the handle, instead of on the minesweeper's head, and turned the volume to its maximum level. This procedure allowed both the safety observer and the minesweeper to hear the detector's "beep." For this procedure to be effective, the safety observer had to be close enough to hear and see everything. Thus, the safety observer remained a maximum of 12 paces behind the minesweeper.
- Finally, the CMSI personnel were trained to overlap sweep areas by half a detector head length. This practice ensured that the area was accurately covered and left little chance for error.

Engineer School Recommendations

Engineer units should continue to follow the countermine doctrine found in FM 20-32. If your unit is tasked for a demining mission, immediately call the Engineer School at (314) 563-4007 for assistance. Other recommendations follow:

- When training for a possible deployment, units should train mine detector operators with the actual types of mines found in theater. This will enable the operators to clearly hear the tone that represents the metallic content for the types of mines they expect to encounter.
- Periodically check the springs in the battery compartment of the AN/PSS-12. After extensive use, the springs lose tension and batteries may not maintain a good connection. To restore tension, pull up on the springs with a pair of needle-nosed pliers.
- Use only alkaline (not rechargeable) batteries in the AN/PSS-12 mine detector. When rechargeable batteries are used, the detector will not activate the low-battery light or indicate when the batteries are dead.
- Engineer units must carefully widen breach lanes created from mechanical breaches (mine plows) or blast-type breaches (MICLIC). Mine plows push mines and soil to the sides, creating berms. When vehicles pass through the lanes, vibrations cause the berms to deteriorate and mines are exposed. The exposed mines may slide back into the lane during movement.

The United Nations is looking closely at banning the use of land mines under a Geneva-type convention. However, reality today is that land mines are weapons of choice for many nations. Export of land mines also provides needed hard currency to some countries. Because the mine threat still exists, U.S. Army Engineers must remain vigilant and trained.

WARNING

The previous article contains issues and techniques that are NOT in accordance with Army doctrine and should not be used by field units without the express approval of the Engineer School Commandant. The methods described were used successfully by Commercial Munitions Systems International personnel in Kuwait. Some of the methods are unique to the Kuwaiti environment and may not apply to other environments. If your unit is tasked to conduct demining operations, immediately call the Engineer School at (314) 563-4007 for assistance.

Captain Chirio is an evaluator with the Directorate of Evaluation and Standardization, at the Engineer School. Previous assignments include company commander, 10th Infantry Battalion, and assistant S3 with the 44th Divisional Engineer Battalion. He is a graduate of the Engineer Officer Advanced Course and the Combined Arms Services Staff School.

Letter to the Editor

Map Scales

I commend you for putting out a publication that is truly beneficial to all Army engineers. It was with dismay, then, that I read and reacted to a small matter of possible misinformation in your February 1994 issue. In the article "Lessons Learned: Midwest Flood of 1993" (page 28), the author, Mr. Vern Lowrey, stated that, "Large-scale maps were used primarily in Emergency Operations Centers (EOC), while the small-scale maps were used by units and personnel on the ground." I doubt seriously if this was the case. It must be remembered that small-scale maps are designed for use in EOCs (i.e., 1:250,000 maps—they cover more area with less detail), while large-scale maps are designed for small unit and individual soldier use (i.e., 1:50,000 maps—they cover less area with more detail. It is possible that Mr. Lowrey made a common mistake of confusing the terms "small-scale" and "large-scale."

I also reluctantly take exception to Mr. Lowrey's recommendation regarding the Maps topic on page 28. As task force engineer of Task Force Hawkeye during Hurricane Hugo humanitarian assistance in the US Virgin Islands and in other associations with similar operations, I have observed that, due to the rapidity of deployment, units usually deploy with minimal map support. Additionally, the quality and accuracy of the maps are often poor and are likely to be non-standard. In my current assignment at the Defense Mapping Agency, I remain amazed at the large portions of the world where either no or quite old map coverage exists. Therefore, the likelihood of a unit being deployed rapidly to an area of the world where minimal or no map coverage exist is quite good. Yet, despite this likelihood, Mr. Lowrey recommends that units "train with updated maps and products for potential disaster relief operations areas."

It is my contention that units, at all levels, should conduct some part of their training using minimal non-standard map products. This action would ensure that units are exposed to situations that are more realistic than that perfect world which usually exists in my experiences with Army and Joint exercises.

I send this letter to you as friendly criticism of a perceived small error and a difference of opinion regarding where training should focus. It is not to be construed as an overall negative criticism of your fine bulletin. Keep up your good work. Essayons!

Major Stephen E. Lowe
Defense Mapping Agency
Bethesda, Maryland

Mr. Lowrey replies: I appreciate Major Lowe's topographic insights. I should have stated "The large-area maps were used primarily in Emergency Operations Centers, while the small-area maps were used by units on the ground." Hopefully, his comments will clear up confusion between map scale size and coverage area. As stated in my recommendation, it is critical that units assess and try to acquire needed topographic products of potential disaster relief areas prior to training and operations, to preclude possible delays in getting maps.

The Schiebel AN19/2 Hand-Held Mine Detector:

A Canadian's View

Lieutanant Colonel Normand Levert, Branch of Military Engineers, Canadian Armed Forces, spoke to Catherine Eubanks about the Canadian Army's experience with the Schiebel AN19/2 Mine Detector. The Schiebel AN19/2 is the commercial designation for the AN/PSS-12 detector used by U.S. Army engineers.

I am Lieutenant Colonel Normand Levert, and I'm now with the Directorate of Military Engineering and Requirements in the Canadian National Defence Headquarters, in Ottawa. I was involved with the procurement of the mine detector, first as the requirements officer and then as the project manager, because I was the life-cycle manager for combat engineer systems in Ottawa.

In the late 1980s, we had a program to replace our hand-held mine detectors. Before making a selection, we first turned to our scientists and the scientific laboratories' defence research establishment, as we call it, to perform scientific tests on several commercial and military mine detectors. The Schiebel AN19/2 (we call it the AN19) came up as one of the very top ones along with the Förster METEX detector. The other detectors were not nearly as satisfactory as those two. We also performed several tests with our field troops (engineer platoons) to determine user confidence and satisfaction with how the mine detectors performed in field conditions, and how happy the soldiers were with the feel, size, weight, and performance of the detectors.

A major concern in the selection process was whether or not a magnetic impulse along a pulse-induction coil would create a magnetic field which would trip a magnetic-influence fuze. We knew that the German Army was doing tests for that same problem since they had adopted the Swedish FFV mine. Through a data exchange we were able to obtain the German Army's test results, and they showed that the Schiebel AN19 was the only detector that consistently never triggered the magnetic-influence mine, at least not the FFV mine. So in terms of sensitivity, the AN19 was, in fact, the best rated mine detector. It was also the one that had no likelihood of inducing detonation in the magnetic-influence mine. Our troops liked the AN19 very much, so we procured it for our armed forces. We made an immediate procurement for troops stationed in Europe and then filled in for the rest of our forces back in Canada.

Shortly after receiving the mine detectors, we got our first operational exposure to its performance when we went into Kuwait with the United Nations (UN). We sent a battalion into Kuwait to establish a demilitarized zone between Kuwait and Iraq. Their mission was to clear a road and then clear areas and construct observation posts all across the border between Iraq and Kuwait. The AN19 performed extremely well in this environment. It already had a good reputation for performing well in a hot climate: the Danes had used it in Beirut, and we were also getting good reports from civilian companies involved with demining operations.

One problem we experienced in Kuwait was that the insulation on the coils melted if soldiers rested the mine detector on the hot, burning sand. The trick to solving that problem was to put something like a bonnet around the search head coils to give enough insulation and distance.

Another thing we found in Kuwait was that the search head's plastic mounting posts had been cut too far apart by the die maker. He tried to improve on the manufacturer's design but then some posts broke off. When we reported that problem to the Schiebel factory, their personnel identified the cause in less than three weeks, rectified it, and then replaced our search heads. They also immediately retrofitted their production lines so that all future search heads would be correct. Overall, our experience with the mine detector in Kuwait was excellent.

Our next demining experience with the AN19 was in Croatia and Bosnia. We deployed to Croatia with an engineer battalion in 1992, and we've had troops there since then. So Canadian engineers have experienced all seasons there. After several months, we received reports of performance degradation in wet weather. It turned out that some water was ingested where the wire enters the search head. Again, the Schiebel factory was able to correct the problem as soon as we had determined the cause.

Canadian troops have a lot of confidence in the AN19 detector, and they have used it both in the hot desert and in the cold in Bosnia. We have consistently found "plastic" mines, including the TMA3, which is a very low metallic contact mine, with the AN19 when they were shallow buried.

Our worst experience with the mine detector was in Somalia. Canadian troops were in Somalia for about 8 months in 1992 and 1993, and we had several armored vehicles damaged by antitank mines. We were able to identify the type of mine that had hit the vehicles by the fragments left in the soil. Then we found more of those mines and demonstrated to our satisfaction that we could find them with the AN19 detector. We had not found them before being hit because an operational decision had been made to take a chance and drive down the road inspecting for visual clues. One visual clue was that the armored carrier (LAV) lost a wheel when it ran over the mine! But our armored vehicles took the mine hits quite nicely: Although the vehicles were damaged, the crews were OK.

Canadian soldiers have strong confidence in the AN19. To help them become confident, we have developed a three-step training process. When sappers first go through our Engineer School, they are given some hands-on training with the mine detector to make them familiar with the equipment. When they come back with their units in the normal cycle of unit training, the sappers get more hands-on time with the detector and practice using it. Then, when a unit is ear-marked to go to a UN mission, or any mission for that matter, the soldiers receive additional training. As part of the work-up for that unit, we provide intense training in first aid, field practice, and various skills such as weapons shooting. Of course, we also include hands-on training with the AN19.

In some cases, we have copies of the mines that are in theater. We may, for example, buy the Yugoslav's training mines from their laboratory and train with them. But training mines are not always exactly the same as the real ones. Therefore, as soon as we get in theater, we gather the mines found in theater and install them in known locations at various depths, and soldiers then practice with actual target mines. In this way, the troops become familiar with the type of auditory signal the target mines emit. So they know what an M15 mine sounds like, and what a bubble cap sounds like, and what a TMA3 mine sounds like. That is how soldiers learn to identify the target mines, although we prod every detection for insurance.

We have found that a demining operation is stressful but, at the same time, it can eventually lead to boredom. Once soldiers are bored, they are not as keen and the operation becomes extremely dangerous. All of our field commanders have adopted a policy of rotating personnel involved with mine clearing or mine searching every 30 minutes at the maximum and sometimes every 20 minutes, depending on the climate.

The demining teams consist of three people: a mine detector, a mine prodder (we use a nonmagnetic mine prodder), and a supervisor. The supervisor follows slightly behind the other two so he can watch the safety of the operation. Again, let me stress that in operations other than war, where demining is the major task, the teams change about every 20 to 30 minutes so they remain fresh, alert and keen.

Yesterday we discussed an interesting physiological problem for soldiers operating a mine detector. And that is to check the auditory accuracy (hearing) of soldiers using the equipment. The signal that the mine detector gives is a steady tone, and the strength of the tone depends on the amount of metal that is perceived by the detector. Thus, a low mass of metal produces a faint tone. The sensitivity of the detector can be adjusted, but if a soldier is looking for a mine that he knows has a large amount of metal, it is better to make the detector less sensitive to minimize the clutter.

Q. Does making the detector less sensitive limit the kinds of mines the soldier can hear? In that case, he might not hear the signal for a low-metallic mine if the detector's sensitivity is set too low.

A. That's right. So, if a soldier is seeking mines that contain only a very small amount of metal, such as the TMA3 found in Yugoslavia, the detector's sensitivity must be turned way up. Then the soldier hears a lot of signals because every time the detector picks up metal, it emits a signal.

Q. Could a cold or sinus condition that might temporarily impair hearing affect a soldier's ability to hear the signal?

A. It could have an effect if he can't hear well. Major Allan, the U.S. Army Engineer School's Canadian liaison officer, has suggested that a field commander should test each soldier's hearing when they arrive at a work site. Each detector comes with a piece of calibration metal of known size and mass. If a soldier can't hear that piece of metal being detected, he should be assigned to duties other than the mine detector. Even listening to loud music can temporarily affect a soldier's hearing.

Q. There are two earpieces with the headphone on the mine detector. Do Canadian soldiers use both earpieces or just one?

A. One earpiece is a dummy. It is only there to keep both ears at the same temperature when soldiers are out in cold weather. One earpiece is open to the outside so the soldier can hear battlefield and environmental noise. The other is hooked up to the detector. So, only one ear listens for the tone. If a soldier has a hearing impairment in one ear, this should be checked.

Q. Must the headphone be on your head to hear the tone? Could you place the piece that normally goes on your ear somewhere else and still hear the tone?

A. Well, it's a question of traditional design. The hand-held mine detector is also used during reconnaissance, when you want to avoid giving a position away. Therefore, mine detectors have been made with an auditory signal as opposed to a light signal or something that must be read because a glow in the dark will give your position away. Today, with the proliferation of night vision devices, a soldier could give his position away quickly. You'd be surprised, when there is a night vision device, how the slightest amount of light turns on the battlefield as if it were a flare or illumination. Not only would the signal light up the soldier holding the mine detector, but everybody within a radius of about 10 meters probably would be illuminated.

Q. The auditory signal, then, is the safest?

A. Well, there is nothing to be picked up. The signal is very weak because it is directed into an ear. But on a very quiet night, if you are calibrating a mine detector too close to an enemy position and the earpiece is not on your ear, that little peep or sound could be picked up several yards away. When calibrating a detector, soldiers usually use a large chunk of metal to make sure the detector is working. In that case, the whistle would be quite loud and the enemy could hear it 10, 15, or even 20 meters away.

Q. Is hands-on time with the mine detector an important part of your training program?

A. Yes, it's very important. Because it is a man-machine interface, soldiers must recognize the signal. They can visualize it in their minds, and that is important too. But, I personally would not want to go into a minefield unless I had three or four days of training time listening to the mine detector before I went.

Q. Would you like to add anything to this conversation?

A. I compared notes with the Belvoir Research Development and Engineering Center at Fort Belvoir in June 1990, shortly after we purchased the AN19, and Fort Belvoir agreed that it is, in all likelihood, the best mine detector in the world.

Thank you.

Jointness—Essayons!

By Colonel Lee Gibson

Joint Operations is the new cliche. The term is used whenever military operations are discussed by almost anyone—military experts, diplomats or politicians. At the national political and military strategy levels it is decreed that military forces operate jointly through the command and control of the unified Commanders in Chief (CINCs). The U.S. Atlantic Command is being positioned now to ensure that the training of all services in the continental United States maximizes "jointness." All recent and emerging military doctrine at least speaks to this concept, and FM 100-5 is no exception. The question is, what are we, Army engineers, doing to help shape our "joint engineering" destiny? I offer some recommendations.

Army engineers need to seize this opportunity to shape our future while jointness is still in a formative stage. We must work together at all levels—strategic (national), operational and tactical—to develop future policies for acquisition, doctrine, force structure, training, and operations across service lines.

Strategic Level

At the strategic level the Army is internally deciding its future through the Force XXI effort. Similarly, the Department of Defense (DOD) is deciding the future shape of jointness, including engineers, through its Roles and Missions Studies (RMS). Because of funding reductions and the resulting downsizing of the services, Congress directed the DOD to conduct the RMS and look for efficiencies across service lines in the acquisition, doctrine, force structure, training, and operations programs.

The first RMS was conducted under the direction of the Chairman, Joint Chiefs of Staff (CJCS). During the conduct of that study, the senior Joint Staff leadership discussed the feasibility of consolidating all engineers across service lines. One of the final recommendations forwarded by the Joint Staff to the CJCS was that all construction engineers (Army Combat Heavy, Air Force Red Horse, and Navy Seabees) become Army Combat Heavy engineers. That recommendation was not accepted by the CJCS and was not in the RMS report to Congress. Instead, the RMS report to Congress emphasized the complementary roles of each services' engineers. Some consolidations and efficiencies were recommended, however, and are currently being executed. One example is the consolidation of engineer training among the services' schoolhouses. Army, Air Force, Navy, and Marines will train together soon at each of the services' engineer schools, based on the soldiers' MOS.

A second RMS, under the direction of the Secretary of Defense, is in progress. This study provides another opportunity for joint engineers at the strategic level to shape the future of joint engineering. Shouldn't Army engineers try to tackle the hard questions of roles and missions now, before someone else's study tells us how to do it?

Engineers from each service should seize the second RMS as a second strategic-level opportunity. They should continue the initiative established in response to the first RMS: Establish joint working groups under their direction to investigate potential areas of benefit in engineer acquisition, doctrine, force structure, training, and operations programs. Their focus should be to increase engineering interoperability from a joint perspective.

For example, why can't the joint services consolidate the research, development, and acquisition of engineer equipment—construction as well as combat? Why can't joint service engineers use the same construction standards and even the same construction management and component systems? Maybe the joint services should delineate some responsibilities. For example, perhaps only the Navy should be responsible for port construction—Army and Navy engineers currently share that responsibility. With Joint Staff approval, delineations such as this might help engineers determine where to take force structure cuts and justify their structure within their services.

Based on DOD experiences in Operations Provide Comfort and Provide Hope, the joint services need to develop more effective doctrine for engineer planning and execution in joint operations and contingencies. The DOD schoolhouses should

(Continued on page 42)

Old Ironsides Sappers Expand Traditional Roles During BCTP

By Colonel Edwin J. Arnold and
Lieutenant Colonel William J. Bayles

During the first two weeks of February 1994, the 1st Armored Division (AD) participated in a highly successful battle command training program (BCTP) exercise. The 1st AD Engineer Brigade supported this warfighter exercise by deploying command posts at the brigade and battalion levels, thus providing the division with full doctrinal engineer support. Some of the techniques the brigade used helped "expand the envelope" of normal doctrine while enhancing its contribution to the division's warfighting effort. This article describes the areas of expanded engineer planning and support that we believe exceed current practice, so we can share the ideas with the engineer community. The ideas apply to heavy and light force engineer units that support combat operations.

Parallel Planning

From the beginning, we explored more efficient ways of doing business. When division received the operations plans from V Corps, we surged the whole planning capacity of the engineer brigade headquarters to give comprehensive mobility/countermobility/survivability (MCMS) input into the division orders process. By doing this, we developed a robust engineer annex that also doubled as the engineer operations order. This parallel planning process assured complete battlefield operating system (BOS) integration at the division level and provided time to war-game engineer operations in conjunction with war gaming the division plan. We derived two benefits from the process: a decision support template (DST) and engineer synchronization.

Decision Support Template. Because of the detailed war-game process, we were able to develop a detailed engineer DST. Prepared in matrix form similar to the division DST, it helped track the numerous "on-order" and "be-prepared" missions and keyed the brigade commander to the critical BOS decisions, both in time and place. Figure 1 shows the template.

Although the DST appeared to be time-based, it was actually event-based. By referring to the DST as the battle unfolded, the engineer main command post (CP) could anticipate MCMS demands and allocate resources where needed. Because the DST was developed early in the orders process, subordinate battalion commanders could use it when they helped maneuver brigade commanders develop their orders. The DST helped the engineer battalion commanders understand the engineer brigade commander's intent for MCMS support to the fight.

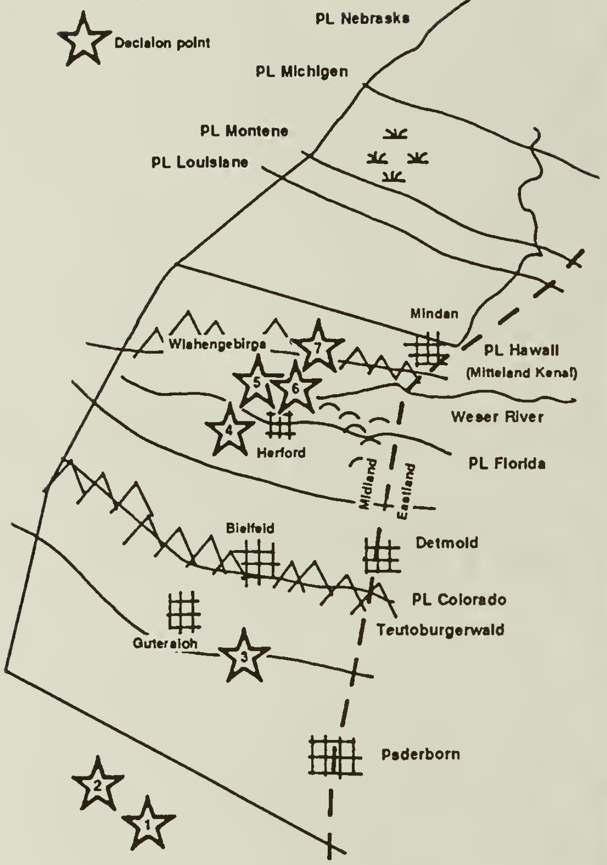
Engineer Synchronization. The time gained by conducting detailed planning in conjunction with the division planning process, provided an opportunity for detailed synchronization of MCMS operations across the division and from the division to the

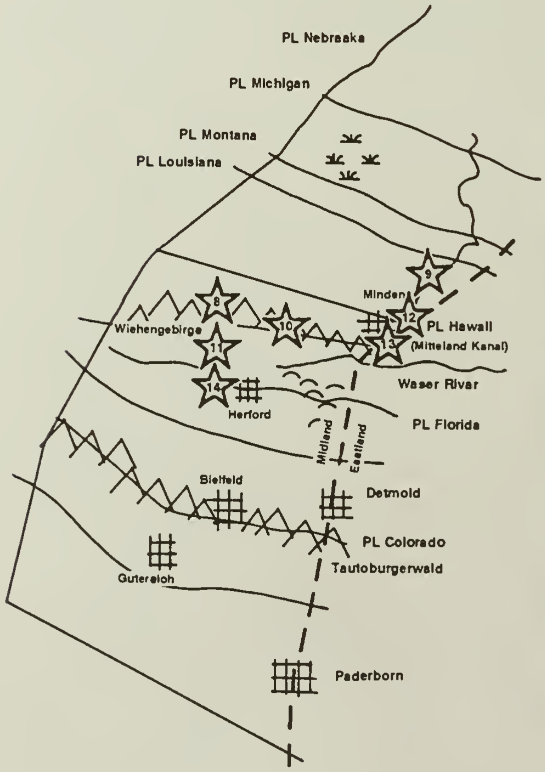
1AD Engineer Brigade

Decision Support Template

(Ironsides Victory II)

Phases I and II





Decision	Trigger	Unit	Location	Time	Purpose
☆1 Employ digging assets for survivability of 4BDE FARPS @ H + 2.	FARPS enroute to locations vicinity PL Colorado.	1457 EN 535 CSE	TAA Hastings	H + 2	To protect friendly center of gravity/-decisive point.
☆2 Recover engineer assets from 1-1CAV vicinity PL Colorado.	1-1CAV enemy contact/decisive engagement in T-WALD passes.	A/23 EN A/12 EN	TAA Hastings	H + 2	To maintain unity of engineer effort across the division sector/-force protection.
☆3 Recover engineer assets from 1-1CAV vicinity PL Queen.	1-1CAV enemy contact/decisive engagement in W-GEBIRGE passes.	A/23 EN A/12 EN	Vicinity CP-495 on Route Pear.	H + 4	To maintain unity of engineer effort across the division sector/-force protection.
☆4 Move to assume division Crossing Area Command @ Mittelland Kanal NLT H + 10.	Bridges on MLK destroyed; CG directs division river crossing.	DIVENG	PL Florida	H + 6	To rapidly project combat power across MLK; to maintain momentum to the north.
☆5 Mass 1457 EN assets to begin MBA Phase II preparation @ H + 15.	1BDE w/division deception @ PL Hawaii.	1457 EN 535 CSE	PL Queen	H + 13	To set the conditions for rapid transition to the defense.
☆6 Employ A/12 EN (-) east of Weser River to emplace A99 and A98 w/1457 EN @ H + 15.	3BDE in CFA set; 1-1CAV occupying economy of force sector.	A/12 EN	PL Queen	H + 10	To anchor division defensive scheme of maneuver in the east.
☆7 Emplace AFB assets on Weser River vicinity Minden @ H + 15.	1-1CAV east of Weser River; 38 MGB not available.	502 AFB	PL Queen	H + 14	To maintain operational flexibility in the 1-1 CAV economy of force sector.
☆8 Destroy division directed targets on the Mittelland Kanal.	Enemy regiment-sized units cross PL Montana.	1457 EN	PL Queen	H + 20	To shape division battlefield by "thinning out" crossing sites on MLK.
☆9 Replace 502 AFB w/MGB assets on Weser River vicinity Minden.	1457 EN crosses Weser River to MBA missions; 38 MGB arrives forward.	1457 EN	PL Queen	H + 20	To maintain operational flexibility across the division sector; preserve AFB assets for future operations.
☆10 Employ digging assets in support of division deliberate decon operations.	Enemy potential chemical strike to fix 1-1 CAV in economy of force sector.	Available "clean" unit	PL Queen	H + 25 (+)	To protect the force.
☆11 Reassess allocation of engineer assets across division sector.	Availability of host nation assets.	All	PL Queen	H + 25	To maintain unity of engineer effort across the division sector/force protection.
☆12 Retrieve engineer assets from 1-1CAV economy of force sector.	A99 and A98 complete or enemy battalion-sized units cross PL Montana.	1457 EN A/12 EN	PL Queen	H + 38	To ensure unity and continuity of engineer support within the division sector.
☆13 OPCON A/12 EN to 1-1CAV in economy of force sector.	A99 and A98 complete; location of enemy DAG.	A/12 EN	PL Queen	H + 38	To maintain operational flexibility in the 1-1CAV economy of force sector.
☆14 Emplace F98.	MBA defences near complete; 3/3ID NOT in 1AD sector; penetration of Mittelland Kanal likely.	1457 EN	PL Queen	H + 44	To anchor division defensive scheme of maneuver by protecting Inter-BDE MBA boundary.

Figure 1. Decision Support Template

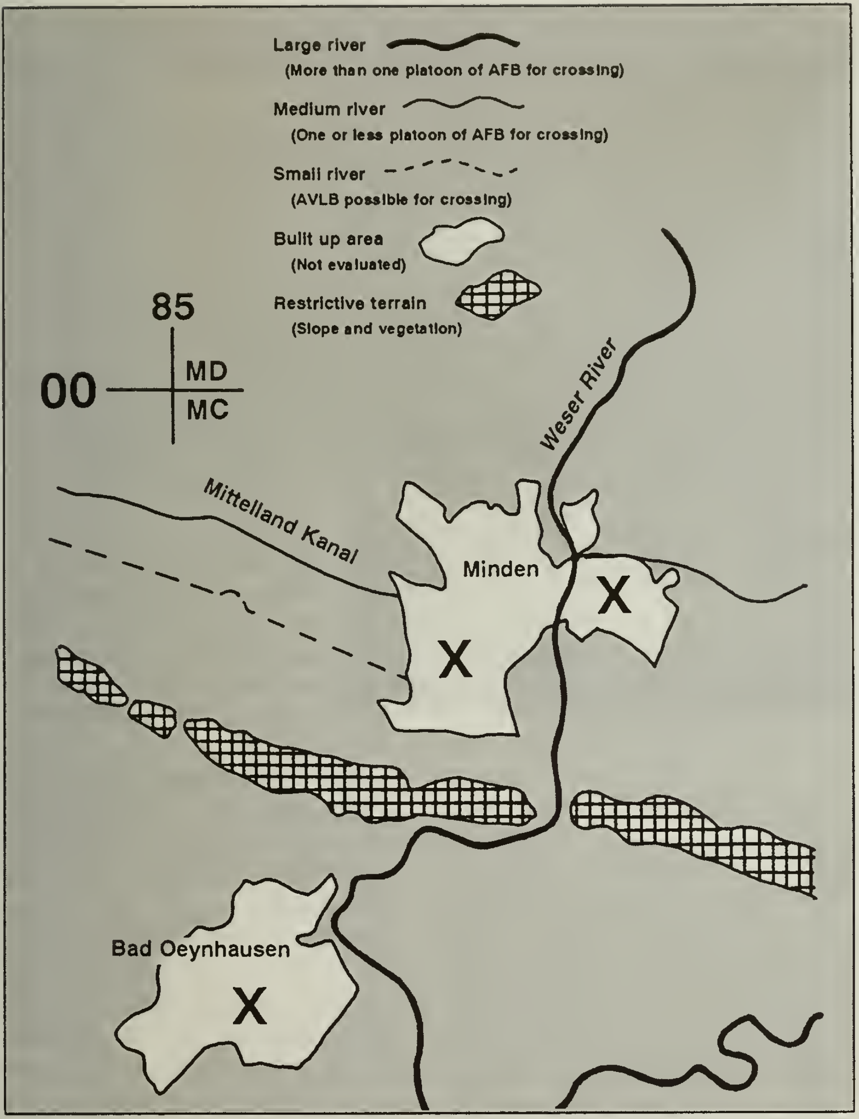


Figure 2. Commander's modified combined obstacle overlay (CMCOO) is less detailed than a normal MCOO and does not obscure underlying maps.

maneuver brigade. After publishing a detailed warning order (WARNORD) (a nearly complete version of the final annex), the brigade S3 and the ADE conducted an order "executability" session with subordinate battalion S3s. The session provided valuable initial insights into the maneuver brigade plans and helped eliminate problems in the annex before the final WARNORD was published.

Additional BOS synchronization took place after the division published its order and while the maneuver brigades were completing theirs. An orders backbrief, a synchronization drill, and a map rehearsal, given in sequence, provided subordinate commanders an opportunity to discuss, with the engineer brigade commander and each other, how they would support the maneuver brigade operations. Crosstalk among commanders and between commanders and staffs ensured that the MCMS plan for the division accomplished two purposes: It could be executed with the allocated resources, and it supported the division and brigade commanders' maneuver plans. The common understanding that the commanders and staffs developed of the MCMS plan paid off during the battle.

Modified Combined Obstacle Overlay

Before conducting train-up exercises, the division's supporting terrain detachment prepared a series of modified combined obstacle overlays (MCOO) to use during the intelligence preparation of the battlefield (IPB) process (Figure 2). These products were standard, multicolor overlays of the entire area of operations (AO). During the preliminary exercises, we rarely used the MCOO for continuous battlefield assessments because the colors obscured the underlying map. Instead, we developed a more usable product—a commander's MCOO (CMCOO). It was a distilled version of the standard MCOO that did not obstruct the underlying maps.

The CMCOO highlighted the obstacle effects of the terrain so commanders and planners could use them during planning and execution. Using standard map colors (blue for water, black for cities, and brown for slope), we outlined the major sections of the AO that restricted movement. In the outlined areas, we showed if the obstacle effect was limited (crossed-hatched) or significant (solid color). We kept the overlay from becoming a "measles-sheet" by establishing two grid squares as the minimum-sized area for consideration. For division- and brigade-level operations, this seemed appropriate. Finally, we coded the waterways in the AO according to the amount of friendly resources required to cross them. We did not highlight very small streams and ditches (less than 15 meters) because they offered little impediment to advancing battalions and usually required only an AVLB to cross. We used the following convention for waterways:

COL Edwin J. Arnold, 1AD DIVENG Commander, provides planning guidance to the Assistant Division Engineer, MAJ Alex Dornstauder and DIVENG HHC Commander, CPT Tony Wright.

Small waterways - 15 to 50 meters wide, required either a ribbon bridge platoon or a medium girder bridge set to cross and were shown as fine blue lines.

Medium waterways - 50 to 100 meters wide, required a ribbon bridge platoon to cross and were shown as medium blue lines.

Large waterways - 100 to 200 meters wide, required a full ribbon bridge company to cross and were shown as heavy blue lines.

Waterways greater than 200 meters wide that required more than a single ribbon brigade company to cross would have been shown with very heavy blue lines. This exercise did not have any very large waterways.

The CMCOO was very helpful throughout the exercise. It clearly facilitated the definition of movement corridors for friendly and enemy forces. Because it did not obscure the map, commanders and planners left the CMCOO on their maps during the operations to integrate terrain considerations into their operations and understand enemy options for its operations.

Execution

With the CMCOO, the engineer brigade S2 analyzed the enemy as part of the engineer battlefield assessment. The CMCOO and visible road net indicated probable enemy deployment routes, and the presence of several medium to large rivers indicated where to impede its deployment. Continuing analysis of enemy vulnerabilities led to the engineer brigade's involvement in deep-operations planning, with excellent results.

Deep Targeting. In the AO, five major approach routes led into the 1st AD sector. All routes crossed at least two rivers; three routes crossed three rivers. Our analysis made a vital connection between two seemingly disparate facts: The enemy needed all five deployment routes to mass combat power, and its float-bridge assets were sufficient only to provide a few alternate bridges over the rivers in its way. These facts pointed to a vulnerability—the enemy could be bottlenecked at the river lines if we could deny it fixed bridges. The enemy's float-bridge assets were relatively high payoff targets because they were keys to maintaining the mass and tempo of its attack.

As the enemy began deploying, we confirmed its march routes using moving-target indicator plots, which also showed the timing of enemy deployment. In this exercise, an enemy vulnerability 50 kilometers from the FLOT allowed our commander to shape the battlefield in time and space. Destroying fixed bridges well forward of the FLOT accomplished three important things:

- It slowed enemy deployment and increased enemy vulnerability to deep attack.
- It forced the enemy to use its float-bridge assets primarily in its main attack sector, thereby telegraphing its probable main attack location.
- It increased the vulnerability of the float-bridge units to deep targeting by putting them at predictable places.

The enemy could not afford to lose more than five pontoon bridge

Standard Barrier Packages

Package	Contents	Weight (Ton)	Provides	Approximate Effort
K	1248 AT Mines	21.6	1000m Minefield	10 Platoon hours
L	8 Volcano reloads	22.5	8000m Minefield	8 Launcher hours
M	17.55 Ton demolitions	17.5	40 Road craters 10 Bridge demolitions	110 Squad hours
W	360 Concertinas 99 Pickets 18 Reels wire	16.0	1800m Triple standard concertina fence or 36 Road blocks	6 Platoon hours
X	15 MICLICs with rockets 15 Bangalores	22.0	15 Vehicle breaches 15 Footpath breaches	15 Squad hours

Figure 3

companies from its entire front without seriously impacting its deployment. We placed those five companies on the division's high payoff target list, and the engineer brigade S2 tracked them closely throughout the deployment. Thus, by carrying the engineer battlefield assessment well forward of the main battle area (MBA), we identified a major enemy vulnerability.

The engineer brigade S2 briefed the results of this analysis at an initial meeting with the 1st AD's deep-targeting cell. Once division leadership was convinced of the vulnerability, the division targeted it systematically. First, bridges deep in the enemy's rear area were nominated for destruction by corps's battlefield air interdiction (BAI). These targets ensured that part of the enemy's float-bridge assets would be tied up well away from the battlefield. Then, bridges along the next two rivers were destroyed. As the enemy bypassed the rivers with float bridges, we destroyed the bridges and seeded the areas with Gator minefields. These mines stopped the enemy from using its preferred locations for bridging operations. If we simply destroyed a float bridge, the enemy replaced it and resumed operations in 12 to 18 hours. If we used Gator mines in the attack, the enemy needed 24 to 36 hours before resuming operations.

Besides giving the division lucrative targets for cross-FLOT attacks, our systematic attack of bridges, enemy engineers, and crossing sites successfully disrupted the enemy's deployment and plans. Although able to swim or deep-ford many combat vehicles, the enemy could not mass artillery and bring critical engineer and logistics vehicles across the river lines because the vast majority of those vehicles required bridges. Without these combat multipliers, the enemy could not assemble enough combat power to overwhelm our main battle area defenses. In contrast, our defenses were well developed because the initial fixed-bridge destruction gave friendly engineers and maneuver forces time to prepare the defense.

Barrier Material Management and Movement. The depth and density of engineer obstacles in the division's main battle area were due to the efficiency with which logisticians moved barrier materials. Number of engineer troops, rather than supply of barrier material, was the limiting factor in the 1st AD's preparation. Because deep targeting and attack were effective, division completed all of its initial defensive area obstacle plan and started work on in-depth obstacles when the enemy attack started. Throughout the process, supplies were readily available. Three factors contributed significantly to the availability of supplies: developing standard resupply packages efficiently, moving barrier materials, and locating the Engineer Brigade S4.

Developing Resupply Packages. In recent years, the engineer and logistics communities in V Corps have worked together to develop engineer Class IV and V resupply packages (see Figure 3). They are a compromise between the engineers' obstacle requirements and the wholesale supply system's material packaging characteristics and movement capabilities.

Each package represents a load for a standard 25-ton stake and platform (S&P) trailer. The major subcomponents of each package are factory-palletized types of materials, thus allowing them to be efficiently loaded using forklifts. These features make the resupply packages readily acceptable to the logistics community. Engineer planners like them because each package is defined by number and type of obstacles each will produce and the work effort required to emplace the obstacles. Obstacle estimates for each package are not always 100 percent accurate, but they are precise enough to meet planning needs at the brigade and division levels.

Moving Barrier Materials. In this exercise, two aspects of moving barrier materials were important: moving the initial lift of packages and moving routinely recurring resupply. For the initial lift, the capacity of engineer haul assets and the dedicated haul assets attached to the forward support battalions (FSB) from V Corps transportation units provided the necessary capability.

In the 1st AD Engineer Brigade, we found that by dedicating about 50 percent of the M9 ACE bowl capacity to hauling barrier material, we could carry about 12 battalion hours of barrier material. This critical material allowed us to transition rapidly from offensive or movement operations to a defensive operation. Assets with the FSB carried an additional 12 battalion hours of barrier material as part of the division's combat configured loads. Before we used up the 24-hours worth of material, we activated corps-delivered resupply of barrier materials to engineer forward stockage points (EFSP) (one per maneuver brigade sector and one in the division's rear area) on a 12-hour, reoccurring basis. Each push of supplies contained enough material for an additional 12 battalion hours of engineer effort.

Locating the Engineer Brigade S4. Field Manual 5-71-100 shows the brigade S4 as part of the division rear (DREAR) command post, separated from the engineer brigade main command post (DIVENG Main). We found this to be correct. With a field grade officer who understood engineer logistics requirements in the DREAR, we had a virtually uninterrupted, timely flow of engineer barrier material toward the planned MBA. His expert guidance and close cooperation with the division's logistics planners and material managers were absolutely essential in making the entire resupply process a "push" not a "pull" system—a characteristic that was critical to success. Some DIVENG brigade commanders may argue that they want the services and field grade experience of the brigade S4 at the DIVENG Main CP. We found that the officer is more valuable to the division's overall engineer effort at the DREAR.

Obstacle Planning

Generally, we found the obstacle planning doctrine correct in its current form, with one exception. Because current doctrine specifies that obstacle zones and belts not cross unit boundaries, we usually developed obstacle plans that contained internal seams or gaps that ran along intradivisional boundaries. We realized these seams presented excellent weak points for enemy exploitation. At first we placed obstacle belts across boundaries but abandoned that technique because of the command and control problems associated with it. However, the benefit was that adjacent units were forced to coordinate their boundary actions very closely to prevent gaps.

The solution we adopted to handle "boundary seams" involved placing division-directed obstacle belts in the covering force area (CFA) that covered the seam and turned attacking enemy units into the MBA brigades' battle areas. Engineers supporting the MBA brigades emplaced these belts after coordinating their location with CFA forces. Since the belts were actually part of the MBA, MBA brigades covered the belts with observation and fire. We found this technique to be very useful and experienced no enemy thrust "down the boundary" during the entire exercise.

Applications

The 1st AD BCTP warfighter exercise afforded the 1st AD Engineer Brigade an opportunity to validate and expand the existing doctrine for employment of divisional engineer brigades. The techniques described produced very positive effects on the total division effort by ensuring the total integration of the divisional engineer brigade into the combined arms operations of the division.

Our parallel planning and early movement of barrier materials ensured that we were ready to prepare the defense as soon as the division controlled the battlefield. The CMCOO and battlefield analysis enabled the engineers to play a pivotal role in the deep fight by delaying the enemy's deployment, while our careful rehearsal and its product, our DST, enabled us to make decisions quickly during the battle.

The 1st AD Engineer Brigade will continue to use techniques such as the parallel planning process, engineer DST, CMCOO, and standard barrier packages. We recommend that others consider their application when situations require their support of heavy and light forces.

Colonel Edwin J. Arnold, Jr. is the commander of the 1st Armored Division Engineer Brigade in Bad Kreuznach, Germany. He previously served as the executive officer for the newly formed Engineer Brigade, 3d Infantry Division, and as commander of the 10th Engineer Battalion. COL Arnold received a masters of military arts and science degree from the School of Advanced Military Studies. He is a graduate of the Army War College.

LTC William Bayles is the executive officer, 4th ID Engineer Brigade. During the 1st AD warfighter exercise, he was the XO, 1st AD Engineer Brigade. He was the S3, 1st AD Engineer Brigade during the 1992 1st AD warfighter exercise. A graduate of the School of Advanced Military Studies and CGSC, he is a registered Professional Engineer in New Hampshire.

Earn A Master of Science Degree at EOAC

With the downsizing of engineer forces in today's Army, it is difficult for engineer officers to take 18 to 24 months from their careers for advanced civil school. Additionally, funding cuts have reduced the opportunities for fully funded graduate school, and many civilian education slots for military personnel have been distributed to other branches or eliminated. So how can engineer officers combine a busy career with advanced professional education?

The U.S. Army Engineer School is working to develop alternate methods of professional education. For example, engineer officers can use their time at the Engineer Officer Advanced Course (EOAC) to complete a master's degree. The University of Missouri-Rolla (UMR) will grant credit hours for the 20-week EOAC course. UMR is known internationally for its outstanding engineering programs and is accredited by the Accreditation Board for Engineering and Technology. Active Component officers may remain for an additional 16 weeks after EOAC graduation to complete degree requirements. Reserve Component officers may also attend, if their chain of command authorizes the extension.

To participate in this program, officers must meet UMR enrollment requirements. He or she must hold a bachelor's degree and should have a 3.0 GPA for their last 60 credit hours of undergraduate study. A GPA less than 3.0 may be accepted, but the student will be placed on a "special status" similar to academic probation.

In the USAES-UMR 36-week graduate program, the Engineer Branch extends an officer 16 weeks after EOAC on permissive status, not TDY. Officers accepted will remain at Fort Leonard Wood to complete a master of science degree in engineering management. The program begins the first day of EOAC. Participants will receive a 3.0 credit-hour civil engineering project to complete during EOAC, and partial credit hours will be granted for specific engineering management courses. Students can earn additional credits during EOAC by attending courses after duty hours and on weekends. By EOAC graduation, officers will have earned 15 credit hours. After graduation, they will attend UMR full time, for two 8-week sessions. Each session has three courses for a total of nine credit hours.

The cost is approximately $230 per credit hour or about $5300 for the program, which includes university fees but not books. This compares favorably with the normal cost of more than $10,000 for a master's degree. While the cost is significant, the degree is an investment for the future, and some financial assistance may be available. The Montgomery GI Bill can be used to pay for the program for selected officers. Additionally, the Engineer School is working to provide student loans through local credit unions.

The USAES-UMR program is scheduled to begin with EOAC class 1-95 in November 1994. Application forms will be included in the EOAC welcome packets. Completed forms should be returned directly to EOAC, where they will be consolidated and submitted to UMR. Officers are responsible for obtaining their certified undergraduate transcripts for the UMR admissions office.

The Engineer School's goal is for officers to complete the UMR master's degree program and become eligible to take the Professional Engineer Examination. Professional Engineer Registration for the State of Missouri requires four years of engineering experience to qualify for the Professional Engineer Examination. One year of experience is granted for applicants who possess a master's degree in engineering. The Engineer School is working with the Missouri Board of Professional Engineers to recognize military experience. A recent accomplishment is that an officer will receive two months of engineering experience for each month of combat experience. UMR professors provide review courses for the PE and Fundamentals of Engineering Examinations. These aids are available at Fort Leonard Wood for groups of 10 or more students.

Officers who are ready for the challenge can arrive at Fort Leonard Wood for EOAC and leave 36 weeks later with a completed master of science degree and as a Professional Engineer. What better way for an officer to arrive at their next duty station, fully focused on their greatest challenge—command of an engineer company.

The point of contact for the USAES-UMR program is Captain Anthony C. Funkhouser. He may be reached at (314) 563-4124.

Restructured Heavy Division Engineer Support:
A Force Developer's Comments

By Alan Schlie

The engineer restructure initiative encompassed a wide spectrum of engineer missions on the battlefield. It was not created solely for the heavy division's organic engineer unit; it also directly affects the corps mechanized and wheeled battalions and combat support equipment companies (CSE). Overall, the restructuring shifts mobility, countermobility, and survivability assets forward to divisions, while sustainment engineering assets shift to corps and echelons above corps (EAC). In effect, engineers continue to provide support to all areas of the force, but each organization's mission now is more sharply focused.

ALO Tenets	*U.S. National Military Strategy*
Initiative	Project and sustain
Agility	Protect the force
Depth	Win the battlefield information war
Synchronization	Conduct precision strikes
	Dominate the maneuver battle

At first glance, that sharpened focus may not lend itself to the versatility called for by Major General Joe Ballard during opening remarks at the 1994 Senior Engineer Leaders Training Conference. After characterizing the future as one filled with uncertainty, change, and opportunity, MG Ballard called upon the gathered commanders to "challenge the status quo and exemplify engineer versatility" when dealing with engineer issues during the week's sessions.

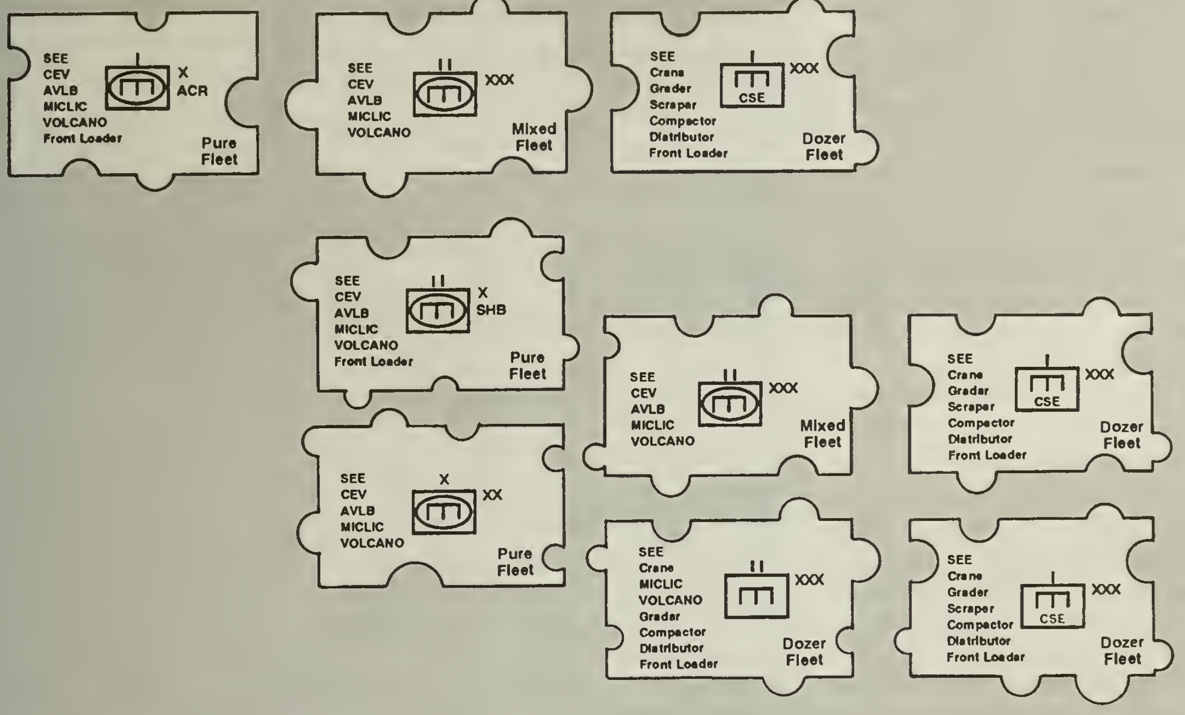
If engineers are to retain their valued position on the combined arms team, versatility must become their trademark! Versatility does not mean diversity; it does not mean more people or more equipment to do more missions. It means more innovative ways of accomplishing the current mission, more ways of making engineers a trusted combat multiplier in the eyes of the maneuver commander, and more sharing of innovative techniques and procedures with other engineer commanders.

To say that the concept focused solely on the offensively oriented tenets of AirLand Operations (ALO) without recognizing the defensive nature of conflicts creates the impression that engineers have fielded a dysfunctional, overly aggressive organization. These units are not only well suited for their doctrinal battlefield missions, they also rank high on the list of units called to clean up after a hurricane or earthquake. The tenets of ALO fit very well with the mission of the Army and the needs of the Force XXI Army of today, which emphasize versatility, as the chart above shows.

The four formations (heavy division, corps wheeled, corps mechanized, and combat support equipment) are capable of executing the mobility, countermobility, and survivability missions required across the operational continuum—from shaping the battlefield forward of the FLOT to mine clearance during relief operations. Each engineer unit plays a part on the combined arms team and has a specific place. That place is determined by the unit's mission, personnel, training, and equipment.

Before executing any mission, the commander must make realistic decisions during mission planning, and those decisions are based on the presence or absence of equipment and personnel. Task completion is based on the capabilities of equipment and personnel, so the presence of specific equipment or personnel indicates an intent for the unit to undertake certain tasks. For example, part of one capability statement for each organization deals with the "repair of trails, roads, and fords." The division battalion is equipped to perform expedient repairs (fell trees for corduroy material and emplace culverts), the corps wheeled battalions can do slightly more (grade and compact and haul gravel), but it takes the attachment of a CSE company to complete most major repairs (move the earth).

Engineer Battlefield Puzzle Pieces - Heavy



Conversely, the absence of equipment or personnel indicates a limiting or exclusion of tasks. Heavy divisional and corps wheeled and mechanized battalions do not have carpenters, masons, or electricians. So those units can perform only the simplest vertical tasks. The rehabilitation of a warehouse facility to support relief operations must be accomplished by another type of unit.

All engineer battalions are not designed with equal capabilities, but that doesn't mean that one is better than another. It means that each has a specific place and function on the battlefield. It also means that each unit can and should concentrate on maintaining proficiency in its METL tasks. And it means that commanders must ensure their superiors know which missions their unit can and cannot accomplish.

The initiative was proclaimed to be a panacea for engineer woes. But almost immediately, perceived shortcomings were loudly denounced—not by the maneuver community but from within the engineer community. While not perfect, it's also not finished. It is as dynamic as the living TOE (tables of organization and equipment) process and field adaptations will allow it to be.

Conversion to the new configuration is still an ongoing activity. The 14th Engineer Battalion, the remaining unconverted Active Component battalion, will reorganize under the L-series TOE in October 1994. None of the Reserve Components' heavy divisional battalions or CSEs have converted, and only a few of the corps battalions have converted. Units that are still organized under the older, H-series TOE need to prepare for the conversion and step forward to become versatile members of Force XXI. They should not serve as sentinels of tradition by retaining the H-series TOE missions.

The Engineer School must develop leaders to handle the significant emotional event of converting a unit to the new designs. Current RC commanders were last in troop units during AOE transitions and before AirLand Battle. But the composition of the restructured units is completely different, the diversity of missions is focused for specific task accomplishment, and equipment has migrated. In short, it is an engineer world that has changed drastically since their last field exposure. Little or none of the "old and familiar" remains for them to feel comfortable with, so commanders must prepare now for these new challenges and changes.

Just as the Engineer School developed transition assistance courses for those engineer groups converting to divisional engineer brigades, it must develop a transition assistance plan for the conversion of a corps wheeled battalion to a corps mechanized battalion. It must deal with issues across the entire DTLOMS spectrum. The Directorate of Evaluation and Standardization is creating a central repository for the lessons learned by transitioning units. It is essential that new organization team training be provided for units whose principal mode of transportation will shift from a dump truck to a tracked armored box. The introduction of a completely new mechanic, the 63Y MOS, demands that special schooling or MOS-producing courses must be programmed. Without an information exchange, the conversion process will result in less than combat-ready, less than combat-capable units.

The jumbled battlefield pieces must be assembled to form a clear picture (see figure, page 41). How so many units, each with a sharply focused capability, interact with one another and with the maneuver element or FEMA (Federal Emergency Management Agency) must be dealt with in all leadership courses—from BNCOC to EOAC. The Pre-Command Course must stress the missions, capabilities, and versatility of engineer units as they exist in the Army today, as well as their interdependence. They must not focus solely on the technological marvels of the future.

When given a mission, leaders must understand the commander's intent, develop a plan according to the resources and time available, and execute the mission to the best of their ability. This is especially critical for engineer leaders in redesigned units that now have sharply focused missions and capabilities. The key is communication! Exchanging ideas and sharing experiences opens the door to creative innovation. The resulting versatility allows engineers to be the combat multiplier maneuver forces will call upon first. Let us hear from you!

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(Personal Viewpoint, continued)

teach all engineer leaders about the capabilities and limitations of each services' engineers and provide lessons learned from previous joint operations and contingencies. With the second RMS, the stage is set strategically to determine the future of joint engineering.

Operational Level

The CINCs are responsible for operational and contingency planning, training and mission execution throughout their area of responsibility (AOR). The CINC engineer staff is critical in defining the roles of engineers tasked to execute that responsibility. Joint operations are mentioned in some manuals, but currently there is no detailed guidance for CINC engineer staffs to follow across the spectrum of planning, training, and mission execution of joint operations and contingencies. The CINC staff engineer, regardless of his or her service, must make all that happen in the AOR in concert with the CINCs' guidance and operational plan. Again, at the CINC level, we now have a great opportunity for engineers to work together across service lines and shape the future of joint engineering.

Each service component's engineer staff must ensure that the CINC engineer staff understands their respective capabilities, both military and civilian. The CINC engineer staff will use that information during joint planning, training and mission execution. I recommend that the CINC engineer staff include service engineer units in joint exercises and staff training. Those events provide excellent opportunities to train together. Additionally, CINC staff engineers should provide lessons learned to the Joint Staff engineers to assist them in developing and updating joint engineering doctrine.

Tactical Level

The JTF commander has three options when employing engineer forces:

- Assign a specific service component to execute all engineer missions.
- Assign several service components to execute the JTF engineer mission. This option was used in Operation Provide Comfort, in northern Iraq, and in Somalia.
- Task organize the JTF primarily with joint engineers. This option is used frequently on missions in the USSOUTHCOM AOR.

In the last two options, the JTF may be as small as company size. Therefore, even at the tactical level, engineer commanders and staff must become knowledgeable about joint operations.

The Future

Engineer commanders should continually seek training opportunities with sister service engineers. Joint training allows soldiers down to the NCO and junior officer levels to operate together and become familiar with each service's capabilities and limitations. We must train as we will deploy and fight!

With budget reductions, downsizing and coalitions looming on the horizon, the emphasis on jointness will increase. Army engineers should lead the way in joint interoperability—at all levels. Now is the time to shape our joint engineering destiny!

Colonel Lee Gibson is commander of the 555th Combat Engineer Group and I Corps Engineer (FWD) at Fort Lewis, Washington. His previous assignment was staff engineer, the Joint Staff, Washington, D.C.

The "New" CSE Company

By Lieutenant Colonel Bruce Porter

Active Component heavy division and corps mechanized engineers have been operating under the engineer restructure initiative concept for several years. Although the new structure has many strengths, commanders at all levels have overwhelming empirical evidence that divisions have a serious shortfall in heavy engineer earthmoving capability. This shortfall results in problems with sustainment engineering and, most importantly, in a division's ability to conduct survivability and countermobility operations as part of close operations.

These shortcomings are not a result of oversights or mistakes in the design. Instead, they exist because combat support equipment (CSE) companies have not yet reorganized to their new design and because the changed mission of the new CSE company has been poorly communicated to field commanders.

Many engineer officers and soldiers mistakingly believe that a CSE company is a specialized road-building unit, heavy in horizontal construction equipment. That's understandable because, previously, a CSE company spent most of its time in division and corps rear areas building and maintaining roads. It moved forward into maneuver brigade areas to augment division engineer earthmoving equipment only when needed. Formerly, a CSE company's priorities were clearly weighted to rear areas, with a secondary mission in forward areas. This is no longer true. Now, as implementation continues and CSE companies reorganize, these priorities will reverse. While retaining its versatility, the CSE company will evolve to a more forward-focused, combat-oriented organization. Its primary mission will change from road building to countermobility and survivability position construction.

Conceptual Underpinnings

Organizational restructuring was profoundly affected by then-current (1990-91) concepts known as AirLand Battle Future and AirLand Operations. Fundamental to those concepts was the notion that divisions should be designed primarily for offensive operations. Thus, the design of heavy division engineer units focused on mobility operations in forward brigade areas, with major increases in the number of combat engineer vehicles, armored vehicle launched bridges, mine clearing line charges, and armored combat earthmovers (ACEs) in the division. The design is not skewed to the offense—just the internal design of some of the units. To provide a limited countermobility capability, division engineer units were designed to employ highly mobile, "dynamic" obstacle emplacement systems such as Volcano. Virtually all heavy engineer equipment was removed from heavy division engineer battalions and corps mechanized engineer battalions. Today, not a single loader or dump truck remains in the design of heavy division engineer battalions.

At about the same time but independent of the initiative, dozers in most heavy divisions were displaced when the ACE was fielded. By the time the new design was implemented, both the capabilities and limitations of the ACE were well known. With its ability to provide mobility support to attacking armor and mechanized infantry, plus its capability to dig to the standard required for a hasty defense, the ACE was an almost perfect complement to AirLand Battle Future concepts. The ACE's known limitations (mostly revolving around a lesser digging capability than that of the D7 dozer) seemed relatively unimportant because it was envisioned that division units would rarely engage in major deliberate defensive operations that required heavy and prolonged digging and earthmoving.

Army leaders recognized, however, that heavy engineer equipment would still be needed in the division area for many types of operations. In addition to requirements for the seldom-envisioned deliberate defense in forward brigade areas, heavy engineer equipment would be needed for such recurring missions as forward aviation combat engineering and sustainment engineering throughout the division area. In the

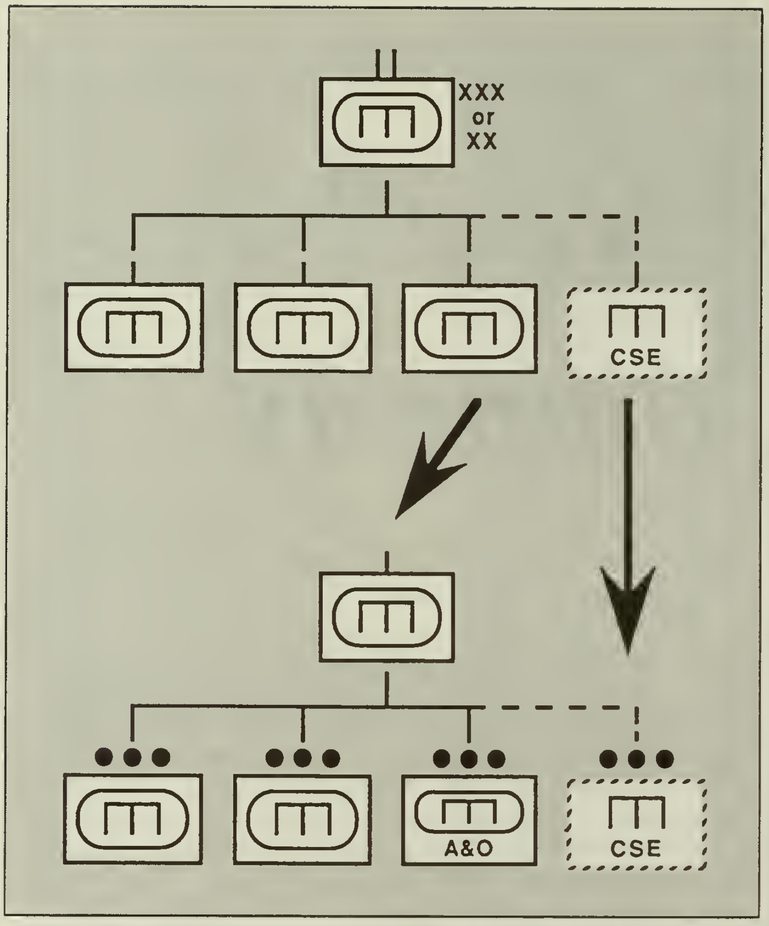


Figure 1. The CSE Company is designed for attachment to a corps (mechanized or wheeled) or division combat engineer battalion to provide heavy earthmoving capability for survivability, countermobility, and sustainment engineering operations in forward brigade areas.

division rear areas, those requirements could be accomplished by engineer combat heavy battalions.

The shortfall lay in the forward maneuver brigades, where division engineer battalions operate. Their missions require heavy engineer equipment for such tasks as digging tank ditches and survivability positions for maneuver and artillery units. Additionally, they provide mobility support and sustainment engineering to forward support battalions. Clearly, engineers need a way to provide heavy equipment to the forward brigade areas. The solution was to provide a module, a unit with heavy earthmoving capability that could be "plugged in" to a division or corps combat engineer battalion.

Concept and Design

The "new" CSE company is designed to be the plug-in unit. It is the repository of heavy engineer equipment needed to perform both the traditional mission of combat trail construction and maintenance and the new primary mission of providing assets for survivability and countermobility tasks in the forward brigade areas. This CSE company is carefully structured so that, when the corps is viewed as a whole, there is virtually no net loss of earthmoving equipment caused by the reorganization of units. Instead, the equipment migrates from the division and corps combat engineer battalions to the CSE companies. To maintain a constant amount of equipment within the corps, the number of CSE companies per heavy division will double to about three companies per heavy division.

The modular design of the CSE company and its platoons allows efficient task organization to division or corps combat engineer battalions for mission accomplishment (Figure 1). The CSE company headquarters is lean. Being austere, the headquarters provides only minimal command and control over its own assets, although it has direct support maintenance capability for engineer equipment. There is no capability for staff planning, engineering design, or construction management; these functions are provided by the division or corps combat engineer battalion to which it is task organized. Instead of one earthmoving platoon and two route clearing platoons, as in the old design (Figure 2, page 45), the new CSE company has three line platoons (Figure 3, page 46). This configuration facilitates task organization of the company and its platoons. When task organized to any type of combat engineer battalion, a CSE company's three platoons may be further task organized to the battalion's three line companies. When only a single CSE company is task organized to a division engineer brigade (as might happen if the corps commander decides to weight the engineer effort elsewhere), the CSE company can task organize its three platoons to the division's three organic engineer battalions.

Doctrine Takes An Unexpected Turn

Recent doctrinal changes in FM 100-5 have made the CSE company an even more important part of restructuring than originally envisioned. The concepts in *AirLand Battle Future and AirLand Operations* were, for the most part, never implemented. Instead of emphasizing the offense over the defense as envisioned in *AirLand Battle Future* and *AirLand Operations*, the 1993 version of FM 100-5 establishes a balance between offensive and defensive operations. This keystone doctrinal manual reaffirms a continuous requirement for a heavy earthmoving capability in forward areas. It underscores the importance of the CSE company as augmentation to division engineers and as a major component of the combat engineer task organization in the maneuver brigade.

Operations other than war (OOTW) are a primary feature in the new FM 100-5, and they were prominent in recent Army operations. Although organized under the old design, CSE companies played a major role in both Hurricane Andrew and Somalia relief operations, where they executed tasks vital to the mission. They cleared rubble, constructed and maintained roads, and constructed base camps while under the control of either division or corps engineers. Because of their versatility and the need for more heavy engineer equipment when either heavy or light divisions conduct this type of operation, CSE companies will play an important role in future OOTW scenarios.

Functions and Roles on the Battlefield

The reversal of mission priorities for CSE companies is shown by comparing the equipment densities in Figures 2 and 3. The changes in relative numbers and types of heavy equipment support their new primary combat mission: to reinforce division and corps combat engineers when executing survivability and countermobility tasks in forward brigade areas. For example, soldiers in CSE companies dig fighting positions and tank ditches; provide protective positions for artillery, mortars, aviation and air defense systems, command and control nodes, and combat service support units and assets; and improve ford and river crossing sites. The CSE companies are robust enough to construct and maintain combat trails that enhance the mobility of maneuver units. They also can sustain the combat force by improving the forward support battalion's ability to receive and move supplies and equipment. Note, however, the reduction in heavy equipment specifically geared for road building (except where necessary to increase equipment to make multiples of three).

Division and corps rear areas also have large requirements for engineer earthmoving support. Requirements are generated by aviation brigades (landing pads, maintenance facilities, refuel and rearm points); division support areas (with both the main support battalion and reinforcing corps support command units); hospitals; ammunition and other supply points; and main supply routes between corps and division support areas. The new CSE company retains the technical ability to accomplish many of these missions, although they are not the primary responsibility of the division engineer battalion or the CSE company. Instead, engineer combat heavy battalions, reinforced when necessary by construction support companies (CSCs) with quarry and asphalt equipment, usually have those missions.

Though it is feasible and may be desirable based on a commander's assessment of METT-T (mission, enemy, terrain, time, and troops available), the new CSE company is not designed to be task organized to combat heavy battalions to engage in rear area construction missions.

A Battlefield Laydown

Based on allocation rules, total Army force structure will ultimately authorize about three CSE companies per armored and mechanized infantry division (allocation rules are more complicated than this, but that is the result). Two additional CSE companies are allocated (again, indirectly) to each light division—light infantry, airborne, and air assault. While actual task organization depends on the commander's analysis of METT-T, a heavy division can expect to receive three CSE companies. If the division is the main effort, it may receive more. Even if assigned as a supporting effort, a heavy division can expect to receive at least one CSE company. A heavy division engineer battalion that is task organized to a combined arms maneuver brigade should be able to accept and employ augmentation ranging from one CSE platoon to a full CSE company. In addition to two CSE companies, each light division is allocated a light equipment company (or airborne light equipment company in the case of an airborne division).

The scenario in Figure 4, page 47, shows how an armored division might initially conduct a deliberate defense, then counterattack, and finally take the offense. This division has received its "doctrinally correct" number of engineers from corps (two mechanized engineer battalions, one wheeled engineer battalion, three CSE companies, and one terrain team; the number of bridge companies shown is notional), plus some engineers from echelons above corps. The number of combat heavy battalions is, for the most part, not allocated based on the division but is theater-workload driven. All engineers in the division area are under the command of the engineer brigade commander unless they are further task organized in a command relationship to the division's maneuver units. In this scenario, the intent of the engineer brigade commander is to:

- Task organize divisional engineer battalions to the maneuver

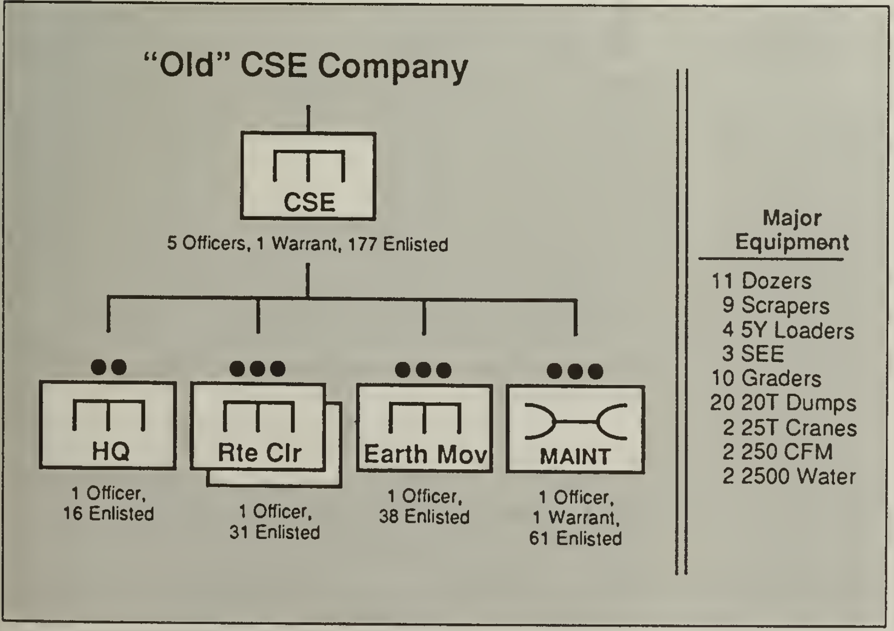


Figure 2. The CSE Company design prior to restructuring.

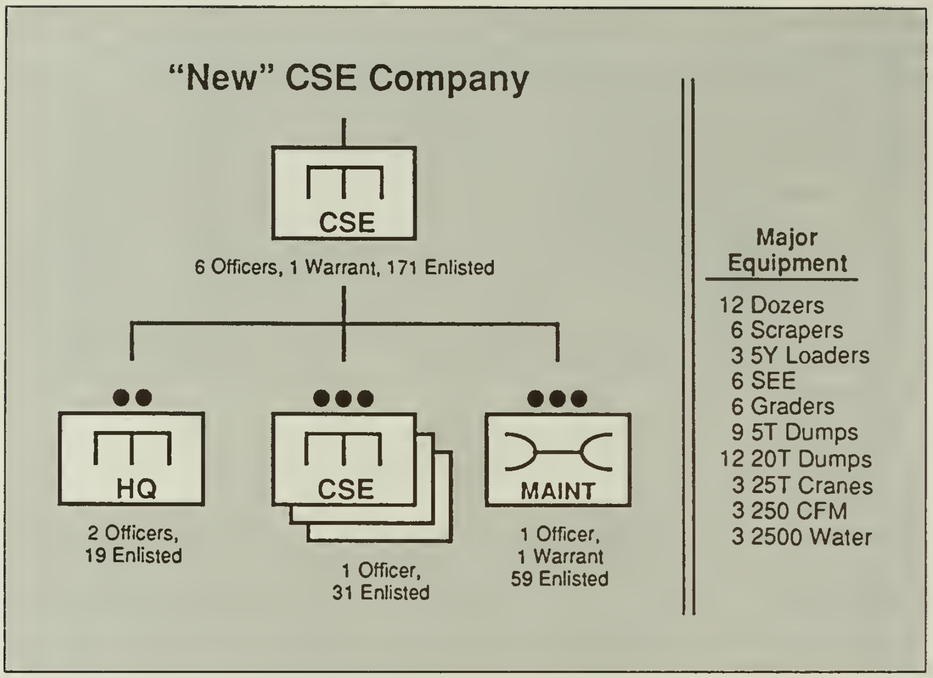


Figure 3. The redesigned CSE company.

brigades with whom they habitually train and fight. Weight the engineer effort to accomplish the division commander's intent. This results in priority to the 1st Brigade in the defense and to the 3rd Brigade in the counterattack.

- Task organize the CSE companies to division engineer battalions for survivability and counter mobility missions that require heavy earthmoving equipment in the forward brigade areas. The CSE effort initially is weighted to the 1st Brigade, with a platoon from the CSE company in the 3rd Brigade moved to operate with the 1st Brigade. Upon transition to the offense, CSE units with each maneuver brigade will construct the network of combat trails needed to conduct the attack, move the forward support battalion, and keep the forward support battalion linked to its supported combat units.
- Task organize corps mechanized engineers to weight the division's main effort and provide engineers to maneuver units that are not "covered" by the organic division engineer structure. A corps mechanized engineer battalion (minus one company) is assigned to the division cavalry squadron to operate as a covering force. The battalion's remaining company is attached to the engineer battalion in the 1st Brigade because it is both the main effort and the "heavy" brigade with four maneuver battalion task forces.
- Use corps engineers to conduct river crossings. This allows division engineers to cross with their maneuver brigade and to conduct combat operations on the far shore. In this scenario, the 3rd Brigade is the division reserve; it must conduct an assault river crossing as part of the counterattack. A corps mechanized engineer battalion will command and control the engineer units that conduct the assault crossing. In the initial stages of the operation, the CSE company in the 3rd Brigade (minus one platoon) will harden the reserve against deep attack and prepare combat trails for the counterattack. Later it will help execute the river crossing by constructing and continually improving crossing sites.
- Task organize corps wheeled engineers to other division and corps combat elements in the division area. A corps wheeled engineer battalion has elements that conduct operations with the division aviation brigade, such as planning and loading air Volcano and providing engineer expertise for air reconnaissance missions. Other elements of the wheeled battalion operate with division artillery units such as the target acquisition battery and multiple launch rocket system (MLRS) battery, as well as the corps field artillery brigade. Command and control nodes in forward areas will also receive support from the wheeled engineers. One company of the corps wheeled engineer battalion is attached to the 3rd Brigade engineers for the assault river crossing.
- Employ combat heavy engineers in the division rear area for sustainment engineering.

Training Challenges

The CSE company's new mission and organization have many implications. As it assumes new responsibilities, the CSE company is no longer a construction unit operating primarily in the rear area; it is part of the combined arms team. Therefore, the company and its platoons must train with division engineer and maneuver units. Training as part of the combined arms team will allow operators to learn how to employ their equipment in combined arms operations, and leaders to know how to coordinate and synchronize their efforts with supported and supporting units. Additionally, units of other branches will better understand the changed role and capabilities of the CSE company.

Engineer leaders continually face challenges and must overcome obstacles with initiative and innovation. Force structure is one example. Because the great majority of CSE companies are now, and will continue to be, in the Reserve Components (RC), Active Component (AC) divisions will rarely have the opportunity to train with "their" CSE companies. Therefore, both AC and RC commanders must make special efforts to provide training opportunities that allow reserve CSE

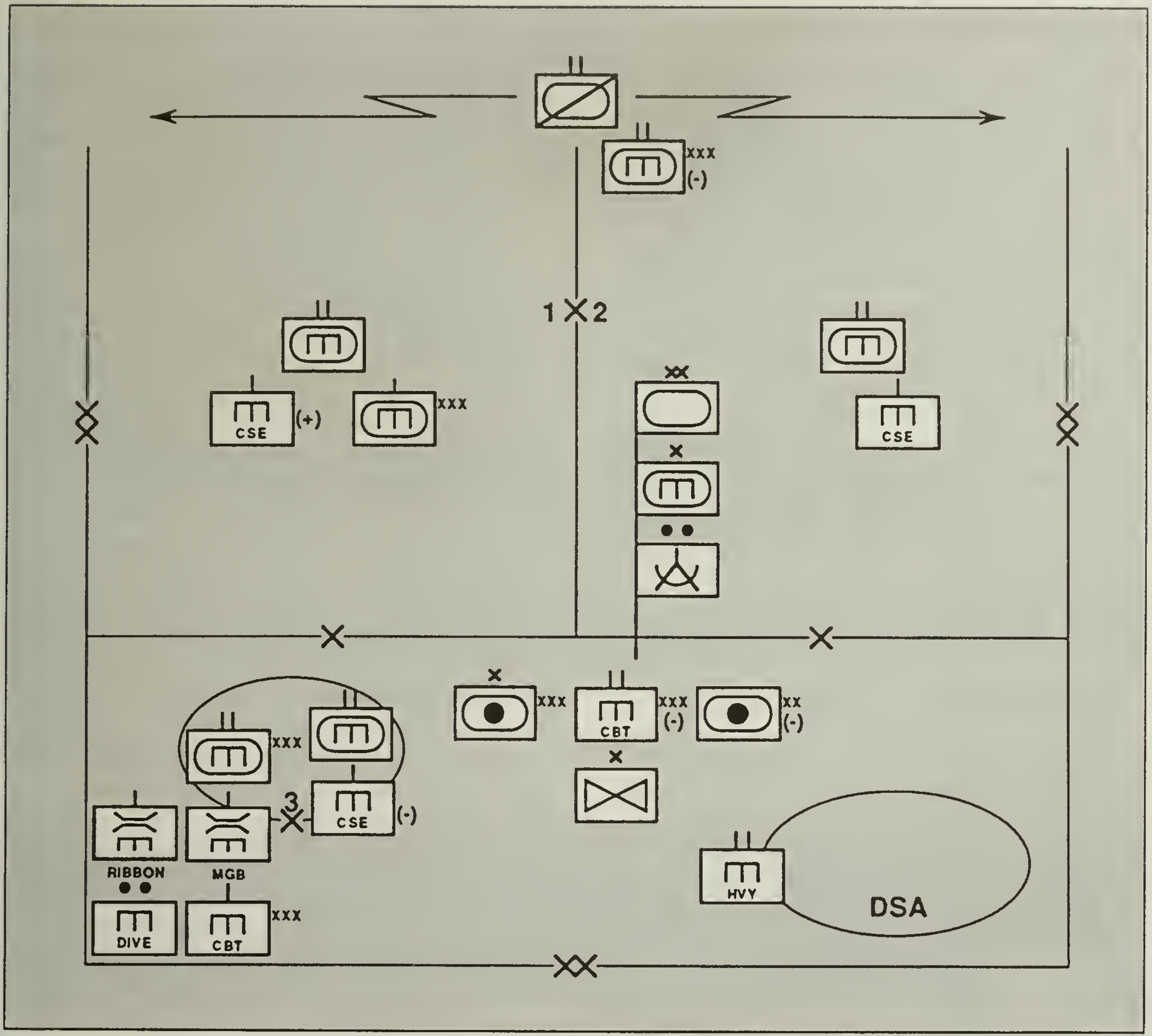


Figure 4. Notional task organization of division, corps, and echelon above corps engineer units in a division area. A division might be weighted with more engineers when it is the corps' main effort, or with fewer engineers when it is a supporting effort.

companies to train with the active units with whom they will fight. One option is to coordinate training during the RC company's annual training period.

Stationing is another challenge for both AC and RC commanders. In war, a CSE company is task organized to the division or corps combat engineer battalion with which it will fight. In peacetime, however, a CSE company is often attached to a noncombat corps or higher organization for administrative purposes. To compound the problem, a CSE company has many assets useful to installation and state support missions. Thus, in times of declining resources, CSE companies may be tasked to execute post or community-support projects instead of participating in combat-oriented training. Again, commanders must ensure their CSE companies receive the kind of tough, combat-oriented training they will require in war.

Some of these challenges are evident in today's training environment, as full implementation of the reorganization has yet to be attained. For example, the task organization for a typical rotation at the National Training Center (NTC) includes a maneuver brigade headquarters, two maneuver battalion task forces, a field artillery battalion, and a forward support battalion.

At NTC, the engineer piece of the task organization consists of an engineer battalion headquarters and two engineer line companies. The maneuver task forces almost always conduct several deliberate defenses that require a large number of tank and Bradley two-step fighting positions and tank ditches, and the forward support battalion generates many requirements for sustainment engineering. Yet, a CSE company or any of its components rarely is deployed as a part of the rotation. The Forces Command regulation governing NTC task organization does not permit deployment and employment of a CSE element. As a result, engineer units execute missions for which they are neither organized nor equipped. Because there are insufficient blade hours to accomplish all required tasks, not all tanks or Bradleys get dug in, and tank ditches are rarely dug at all.

Equipment used by engineers to accomplish these missions, such as armored combat earthmovers and small emplacement excavators (ACEs and SEEs), are not used for their intended purposes. As a result, there is excessive equipment wear and failure—the reputation of the ACE has particularly suffered. Additionally, combined arms commanders do not understand what assets they would receive and employ in actual combat, and

CSE units are not given the opportunity to train as they would fight.

Engineers in many units are trying innovative techniques to overcome these organizational challenges. At Fort Hood, for example, the 68th Engineer Company (Combat Support Equipment) is administratively attached to the 62d Engineer Battalion (Combat Heavy), which is in turn attached to the 13th Corps Support Command, a combat service support headquarters. The 1st Cavalry Division Engineer Brigade is developing a memorandum of agreement to establish an habitual training relationship with the 68th. This relationship will benefit both the division and the engineer company in terms of knowledge, training, and preparation for combat. It is not yet clear to what extent training will be integrated between the two organizations. Hopefully, it will result in routine joint home station training and lead to deployment of CSE elements on division NTC rotations. This agreement is the first step toward full implementation of the battlefield laydown envisioned in the redesign.

Transition to the End State

Reorganization is an on-going process. In the Army's Active Component, the heavy division engineer battalions and corps mechanized engineer battalions have already transitioned. Active corps wheeled battalions, CSE companies, and RC units must also transition in order to train and fight as envisioned in the reorganization. In retrospect, engineers probably should have changed the name of the CSE company when it was redesigned to emphasize its changed configuration and mission.

The CSE company has always been a versatile unit that operates across a wide spectrum of missions. The new design magnifies this versatility, provides a greater degree of modularity to the company, and weights its missions toward the forward areas of the battlefield. Proper integration of the CSE company into division task organizations will provide the earthmoving capability so desperately needed when conducting survivability and countermobility operations.

Lieutenant Colonel Porter is commander of the 20th Engineer Battalion, 1st Cavalry Division, Fort Hood. Previous positions include chief of Concepts Branch, Directorate of Combat Developments, U.S. Army Engineer School; and operations officer, 5th Engineer Battalion, 24th Infantry Division (Mech) in Saudi Arabia and Iraq. LTC Porter has two Master of Science degrees from Stanford University and is a graduate of the U.S. Military Academy and the Command and General Staff College.

Engineer Problem

You are the commander of an engineer company in a mechanized engineer battalion. Your mission is to encircle and secure, by protective wire, a brigade support area in the maneuver brigade's rear area. You must determine the following:

A. Type and number of materials needed to secure the perimeter.

B. Number of man-hours needed to construct the protective wire.

C. Type of trucks and number of truck loads required to transport the material.

You have been provided the following information:

Number of belts: 3
Perimeter: 4,500 meters
Employment: Protective
Type of entanglement: Triple standard concertina
Type of pickets: U-shaped (long and short)

The mission will use experienced troops and will be conducted during daylight hours.

References: FM 5-34, page 3-5 and 3-6, table 3-4
STP 5-12B24-SM-TG, pages 3-195 through 3-198

ENGINEER Solution on page 55.

Pickett's Charge:

The Final Day at Gettysburg

By Captain William G. Garrison, Jr.

Pickett's Charge at the Battle of Gettysburg was the "high tide" of the Confederate Army's invasion of Pennsylvania in June and July of 1863. It was their strongest showing, but it was also the point where the Confederate troops were turned back. By analyzing Pickett's Charge and examining its key events in light of current Army doctrine, Army engineers can learn the following valuable lessons:

- A commander's orders must clearly state his intent and the end state he envisions for his mission.
- Indirect fire must be observed to be effective and to achieve the commander's intended effects.
- Actions that deceive an enemy into responding as we desire increase its vulnerability to losses in personnel and equipment.
- Taking the initiative can force a superior force to retire.

The Battle

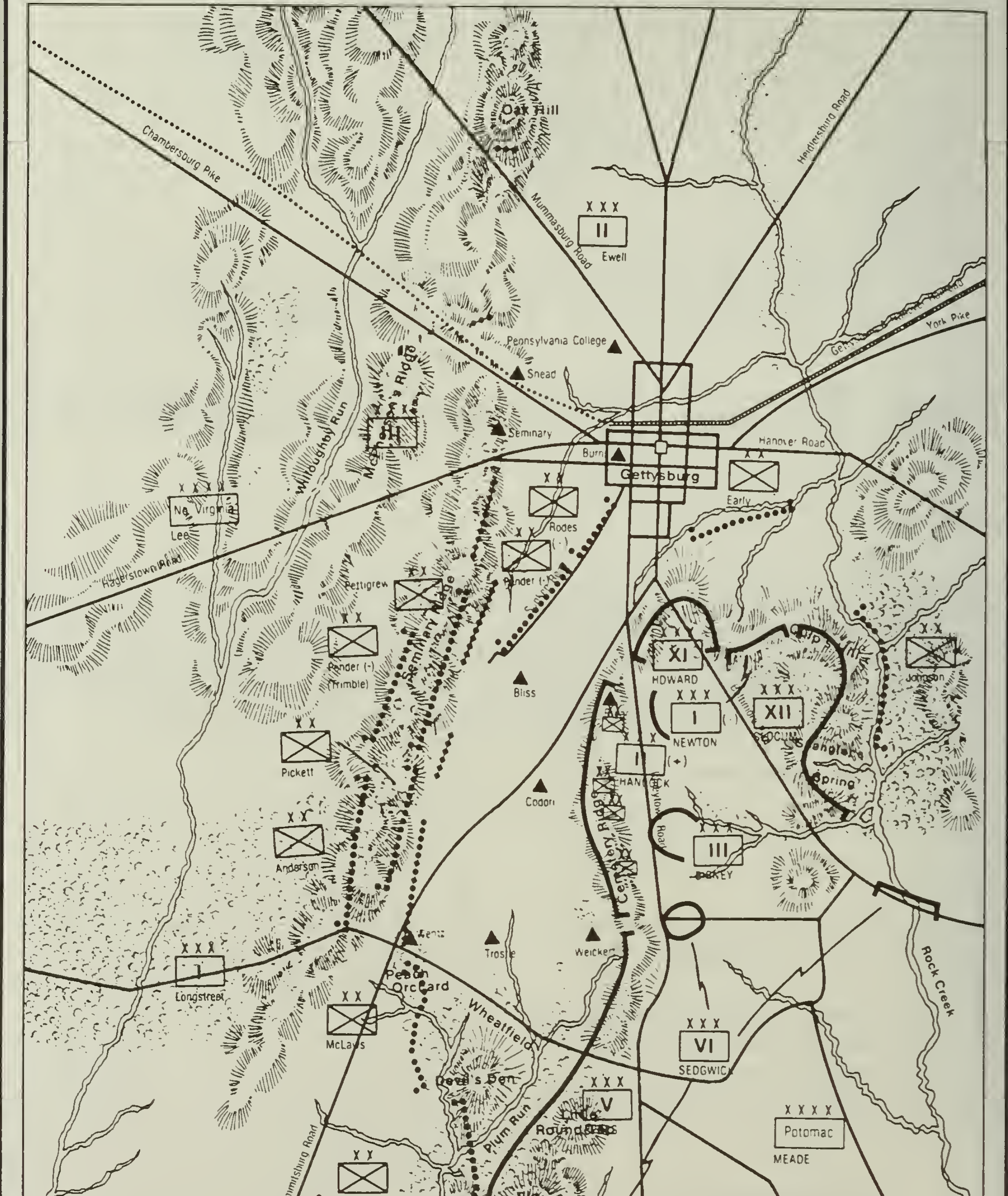
The Battle of Gettysburg took place from 1 through 3 July 1863, when the Confederate Army of Northern Virginia, commanded by General Robert E. Lee, fought against the Union Army of the Potomac, under Major General George G. Meade, at Gettysburg, Pennsylvania. Pickett's Charge occurred two miles south of Gettysburg, across and just east of Emmitsburg Road along Cemetery Ridge, on 3 July.

The events that led these two armies to Gettysburg began with political issues that polarized the nation into North and South. During the 1860 presidential campaign, the issues had centered on slavery and states' rights. On the slavery issue, President Lincoln's intent was not to lead a crusade against it but to prevent its extension into the western territories of the United States. The southern states made the right of states to secede from the Union their main issue. When Abraham Lincoln was elected President, they formed an independent confederation of slave-owning states. The Unionists did not believe that states could secede from the Union.[1] So in 1861, the nation went to war with itself.

After two years of conflict, supplies and manpower were becoming scarce for the Confederate Army, while the Union Army was better able to sustain its forces logistically. Despite this, Lee had defeated the Army of the Potomac in several battles before Gettysburg. Victories at Fredericksburg, in December 1862, and Chancellorsville, in May 1863, helped sustain the morale of Lee's troops and contributed to Lee's view that his army was invincible. An invasion of Pennsylvania seemed to be a viable option for resupplying his army.

After he defeated the Army of the Potomac at Chancellorsville, Lee knew that the Union Army would return to press his outnumbered and undersupplied army toward Richmond, Virginia, the

Artwork from *The Gettysburg Campaign*: courtesy of Combined Books, Inc.



THE BATTLE OF GETTYSBURG

Situation c. 1300 Hours, 3 July 1863
The Confederate Preparatory Bombardment

Note: During the afternoon, Hancock was in general charge of the forces along Cemetery Ridge and Slocum of those on Culp's and Cemetery Hills.

Map taken from *The Gettysburg Campaign*; courtesy of Combined Books, Inc.

capital of the Confederacy. He felt that he had two choices: return to Richmond to await a siege that could lead to surrender or invade Pennsylvania.[2] Invading the North would give Lee's army relatively untouched areas in which to find badly needed supplies and would boost the morale of the South. The invasion could encourage Northern agitators who were in favor of an early end to the war. In addition, success might result in political recognition of the Confederacy by France and England and might cause them to intervene. By threatening Washington, Baltimore, and even Philadelphia, Lee would force the Army of the Potomac to react, which might open it up to destruction. In short, an offensive might win the war for the South.[3] It would also relieve some of the pressure on the Confederacy in other regions by drawing off forces to replace Union losses.[4] Thus, Lee decided that invasion was his best course of action.

14 May

Lee presented his case before Confederate President Jefferson Davis and his cabinet in Richmond. Three days later, President Davis granted him permission to invade Pennsylvania.

4 June

Lee's infantry started north up the Rappahannock River.

9 June

Major General Alfred Pleasonton's Union cavalry corps, with two brigades of infantry, attacked at Brandy Station to drive Major General J.E.B. Stuart's Confederate cavalry corps out of the Culpeper, Virginia, area. The Union troops were repelled, but they performed well against Stuart's cavalry, which previously had "ridden rings" around the Union cavalry. This "made" the Union cavalry and bolstered their confidence for the rest of the war.[5] Criticism of Stuart's performance by the press embarrassed him and would influence events later at Gettysburg.

13 June

At Winchester, Virginia, the vanguard of the Confederate Second Corps, under Lieutenant General Richard S. Ewell, attacked and defeated a Union force of 5,100 and captured an enormous store of munitions. Shortly afterward, Confederate forces crossed into Pennsylvania.

23 June

Stuart received orders from Lee telling him to pass around the Army of the Potomac, "without hindrance, doing all the damage you can, and cross the river east of the mountains. ... after crossing the river, you must move on and feel the right of Ewell's troops." Lee's only stipulation was that the Army of the Potomac "remains inactive." Stuart misinterpreted Lee's orders and thought that Lee was giving him permission to make up for his embarrassment at Brandy Station.

25 June

In the morning, Stuart took his three best brigades on an expedition that was to deprive Lee of his cavalry chief for eight days. This time period included the first one and one-half days of the Battle of Gettysburg.[6]

30 June

Brigadier General James J. Pettigrew's Confederate infantry brigade went to Gettysburg to find a shoe factory that other Southern units had seen. Lee's troops did not have a standard uniform because of resupply difficulties in Virginia; some of them did not even have shoes. Pettigrew withdrew from Gettysburg when Union troops from Brigadier General John Buford's lst Cavalry Brigade arrived. They had gone to Gettysburg to scout for Confederate units near Chambersburg, Pennsylvania. When they learned of each other's presence, Buford and Pettigrew sent messages to their respective armies. Because of this inadvertent contact between two small forces, the two armies converged on Gettysburg.

1 July

Confederate foragers appeared near Gettysburg, which resulted in a hard fight between the Union cavalry and the Confederate infantry. Although the Confederates won this battle, Union forces were able to establish a viable defense on the high ground along Cemetery Ridge.[7] About 23,400 Union troops and about 42,700 Confederates were involved in the battle. The Union forces took about 12,000 casualties; the Confederates took about 8,000.[8]

2 July

The fighting again ended in a Confederate victory, but the Army of the Potomac had escaped complete disaster and was able to occupy relatively secure positions.[9] By the end of the day, the Union had about 71,600 troops on the battlefield and the Confederates about 49,900. Each side took about 8,000 casualties.[10]

3 July

Lee's plan was to hit both ends of the Union line simultaneously, collapse them, and force them to

Artwork and caption from *The Gettysburg Campaign*; courtesy of Combined Books, Inc.

The height of Pickett's Charge in which the attacking Confederate force of 13,000 men lost half its strength as casualties. This etching, taken from a sketch by illustrator Alfred Waud, is perhaps the only visual eyewitness account.

retreat.[11] Lieutenant General James Longstreet would attack the Union left and center with the three divisions that would take part in Pickett's Charge (named for Major General George E. Pickett, commander of one of these divisions). This would occur simultaneously with other attacks to exploit gains of the previous night. Stuart, who had arrived about noon the day before, would attack the Union's rear with his cavalry, which would interfere with Meade's lines of communication. Rather than call a meeting to discuss their views, Lee sent orders to his subordinate commanders by courier.

First Key Event. Longstreet did not fully understand Lee's intent, and his lack of understanding was the first key event of the battle. A commander must ensure that his intent and the desired end result are clearly understood when he gives an order. This will help his troops accomplish the mission the way he wants them to. FM 100-5, *Operations*, states, "The commander's intent describes the desired end state. It is a concise expression of the purpose of the operation and must be understood ... . It must clearly state the purpose of the mission. ... Its utility is to focus subordinates on what has to be accomplished to achieve success ... ."[12] This is a fundamental of planning and executing operations.[13] Because he misunderstood Lee's intent, Longstreet failed to prepare his forces in time to synchronize with the other attacking forces.

Longstreet commanded three divisions, which were under Major Generals George E. Pickett and Isaac Trimble and Brigadier General James J. Pettigrew. The Confederate divisions were on line, with Pettigrew on the left, Trimble just behind, and Pickett on the right. Pickett and Pettigrew deployed their troops in two waves. A small third wave, 100 yards behind Pettigrew, was made up of two brigades under Trimble. To the front and right of Pickett were two brigades that guarded the right flank. There was no guard for the left flank. The terrain over which Pickett charged sloped upward toward Cemetery Ridge, which Union troops were defending. Pickett's troops attacked across a field in plain view of the defenders. In this case, the terrain clearly favored the defense.

Meade's plan for the Union troops was to continue in a static defense. He expected Lee to attack the center of his defensive line in Major General Winfield S. Hancock's sector (see map), specifically along Brigadier General John Gibbon's division front. When asked why he thought so, Meade replied, "Because he has made attacks on both our flanks and failed, and if he concludes to try it again, it will be in our center."[14]

Three divisions of the Union II Corps, commanded by Hancock, defended against Pickett's Charge. These three divisions, consisting of about 8,500 troops, were under Brigadier Generals John Gibbon and Alexander T. Hays and Major General Abner Doubleday. They were on line along the top of Cemetery Ridge behind a low stone wall (see map). They had 26 artillery pieces facing the enemy, with more guns located on nearby hills. Adjacent Union forces were also in direct contact with the enemy.[15] Few of the trees in the area provided cover to the defenders; their main cover was the low stone wall that also provided some concealment.

Second Key Event. At 1300 hours, Confederate artillery began bombarding Union positions with about 150 cannons to soften the positions for a Confederate infantry attack.[16] The barrage lasted two hours, but after the first few rounds smoke obscured their view of Union positions and the Confederate artillerymen began to shoot high. This was the second key event of the battle. The inaccurate fire was mostly ineffective, with no significant damage done to the defenders on Cemetery Ridge. The primary purpose of this artillery action was to destroy the Union artillery to prevent its use against the Confederate infantry. This objective was not accomplished. Without observation of its effects, indirect fire is usually ineffective. If artillery fire is not on target, it does not accomplish the commander's objective. FM 100-5 states, "Subordinate systems and processes for ... assessing battle damage must be fully integrated. Fire support provides for the planning and execution of fires so the right targets are adequately attacked to achieve the commander's intended effects."[17] Fire support is a combat function that helps the commander build and sustain combat power.[18]

At first, Union artillerymen were told to hold their fire to conserve ammunition. Later, some were authorized to return fire to try and raise the morale of the troops that were under heavy artillery fire and to find the enemy guns. A Union artillery officer, Major Thomas W. Osborn, upon learning that Meade actually wanted the Confederates to attack, suggested that the Union artillery cease fire, saying " ... I would cease fire at once, and the enemy could reach but one conclusion, that of our being driven from the hill."[19] At 1430 hours, Union guns began to cease fire to conserve ammunition and deceive the enemy into an early assault. The Union batteries fell silent one by one because it took time for each of the widely dispersed units to receive orders to do so. One battery, with all of its officers either killed or wounded and its ammunition nearly exhausted, was ordered to withdraw and was replaced by a fresh one.[20]

Third Key Event. Earlier in the day, Longstreet had given his artillery chief, Colonel Edward P. Alexander, the discretion to decide if his bombardment was effective enough to follow up with an infantry attack. Seeing the single Union battery withdraw and the diminishing Union fire, Alexander decided that the bombardment was indeed effective and that the time was right for an attack. He sent a message to this effect to Pickett. Pickett received the message and asked Longstreet if he should advance. Longstreet bowed his head. Taking this as an affirmative, Pickett declared, "I shall lead my division forward, sir."[21] Thus, the Confederates attacked before their artillery had its desired effect, which was to destroy Union artillery and weaken the defense on Cemetery Ridge. This was the third key event of the battle. Deceiving the enemy into taking an action we desire increases its vulnerability to losses in personnel and equipment through the principle of surprise. FM 100-5 recognizes surprise as one of the nine principles of war. It states that "surprise can decisively shift the balance of combat power. ... The enemy need not be taken completely by surprise but only become aware too late to react effectively. Factors contributing to surprise include... deception... and variations in tactics and methods of operation."[22]

Fourth Key Event. The Confederates attacked with about 15,000 troops. They advanced in parade ground formation and became perfect targets for rifle fire and canister shot by Union artillery. As troops fell, survivors closed the gaps blasted in their ranks and re-dressed their lines.[23] On the Confederate left, Colonel Robert Mayo's brigade of Pettigrew's division, which had lagged behind the advancing Confederate line, began to catch up and came under flanking artillery fire from Union batteries on the adjacent hills. Immediately, troops began to retreat. Though outnumbered five to one, an understrength regiment of Union skirmishers counterattacked on the left flank of Mayo's brigade. These Confederate troops, already shaken by Union artillery, broke ranks and ran for safety. The left of the next brigade was now exposed to a heavy crossfire, and it began to crumble. This was the fourth key event of the battle and marked the beginning of the Confederate withdrawal. The attack by the Union skirmishers shows that by taking the initiative, one of the tenets of Army operations, a weaker force can cause a superior force to retire. FM 100-5 states, "Attacking commanders gain and maintain the initiative by surprise in their selection of the time and place of attack and the violence with which they execute it. They concentrate forces and execute with speed, audacity, and violence, continually seeking soft spots and shifting their main effort when required."[24]

Pickett's division reached the stone wall after taking grievous losses from artillery and musket fire. At one point, the Confederates came over the wall where Union artillery fire had stopped. This opportunity to penetrate the enemy line was lost as a Union regiment came forward to close the gap. Other Union units also came forward to help. "Within minutes, every Confederate who had crossed the wall was killed or captured." Then, by twos, threes, and finally by the hundreds, the Confederates began to withdraw down the slope of Cemetery Ridge.[25] After one last attempt by Trimble's division to break through the Union line to the north, the charge ended.

The Results

Pickett's Charge was clearly a defeat for the Confederate Army. About 6,500 troops, one-half of the attacking Confederate force, became casualties. In contrast, the Union suffered only 1,500 casualties. Union troops also captured at least 28 Confederate battle flags, possibly 33, but did not lose any of their own. This was a significant indicator of victory by the standards of the day.[26] The Union accomplished its tactical objective of repulsing the Confederate attack and its strategic objective of halting the invasion of Pennsylvania.

This battle and its key events are still meaningful to military personnel today, over 130 years after they occurred. Studying the lessons learned in this battle enables us to see the mistakes of others so we will not repeat them. More than this, we can see that our military doctrine is rooted in many years of experience, accumulated through the blood and sweat of others who have gone before us.

Captain Garrison is the active duty operations officer, Active Guard/Reserve (AGR), 493rd Engineer Group, U.S. Army Reserve (USAR), Dallas, Texas. Previous assignments include platoon leader and construction officer in D Company, 411th Engineer Battalion (C)(H), USAR, Guam. He was also an active duty platoon leader for the 760th Engineer Company (CSE), USAR, in Marion, Virginia. Captain Garrison holds a bachelor's degree from the University of Portland, Oregon. He received the Thomas Jefferson Writing Award at the Engineer Officers' Advanced Course for his battle analysis of Pickett's Charge.

Endnotes:

[1] Macdonald, John. *Great Battlefields of the World.* New York: Macmillan Publishing Company, 1984, p. 90.

[2] Clark, Champ. *Gettysburg: The Confederate High Tide.* Alexandria: Time-Life Books, 1985, p. 12.

[3] Nofi, Albert A. *The Gettysburg Campaign: June - July, 1863*, Revised Edition. Hong Kong: Combined Books, Inc., 1993, pp. 17-18.

[4] Nofi, 17.

[5] Clark, 22.

[6] Clark, 26.

[7] Nofi, 87.

[8] Nofi, 205.

[9] Nofi, 142.

[10] Nofi, 205.

[11] Nofi, 147.

[12] Department of the Army. Field Manual 100-5, *Operations.* Washington: Government Printing Office, 1993, p. 6-6.

[13] Department of the Army, p. 6-0.

[14] Nofi, p. 154.

[15] Nofi, p. 161.

[16] Nofi, p. 165.

[17] Department of the Army, p. 2-13.

[18] Department of the Army, p. 2-12.

[19] Clark, p. 135.

[20] Clark, p. 135.

[21] Clark, p. 136.

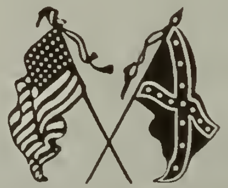
[22] Department of the Army, p. 2-5.

[23] Clark, p. 137.

[24] Department of the Army, p. 2-6.

[25] Clark, p. 143.

[26] Nofi, p. 201.



Engineer Solution

Before solving this problem, you must determine the effective length of the fence and the number of 300-meter sections needed for the fence.

Effective length:

4,500 meters x 1.10 x 3 = 14,850 meters

Number of 300-meter sections:

$$\frac{14{,}850}{300} = 49.5$$

A. Using FM 5-34 and the following equation, determine the type and quantity of materials based on the number of 300-meter sections and the type of wire to be employed. Round up your answers to the nearest whole number.

Table value x 49.5 300-meter sections

1. Pickets:
   Long: 160 x 49.5 = 7,920
   Short: 4 x 3 (number of belts) = 12

2. Reels: 3 x 49.5 = 149

3. Concertinas: 59 x 49.5 = 2,921

4. Staples: 317 x 49.5 = 15,692

B. Determine the number of man-hours needed to complete this project.

30 x .67 x 49.5 = 994.94

Round up to 995 man-hours.

C. Using FM 5-34, you determine that a 5-ton cargo truck will be used. Determine the number of truck loads required to transport the materials.

$$\frac{14{,}850 \times 8.2}{2{,}268} = 53.69$$

Round up to 54 truck loads.

Congratulations if you completed the problem correctly.

This Engineer Problem/Solution was submitted by Sergeant First Class Carl A. Curtice, chief enlisted advisor, engineer team, Readiness Group Pittsburgh.

ENGINEER UPDATE

Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

62B30 Basic Noncommissioned Officer Course (BNCOC) Expanded. The 62B30 BNCOC course, Construction Equipment Repairer Supervisor, has been extended to 10 weeks, 3 days, to allow for automation training in Unit Level Logistics System, Standard Army Maintenance System, and Battlefield Damage Assessment and Repair. POC is LeRoy Mello, 596-0837.

Directorate of Evaluation and Standardization (DOES)

Engineer Bulletin Board System (EBBS). A computer bulletin board system now links the Engineer School with units around the world. EBBS makes school resources such as action officers, fact sheets, and Engineer Branch initiatives available to field units. It also provides a way for field personnel to communicate with school personnel. Subscribers are provided "log-in" software and a user's manual. Minimum hardware requirements are: DOS 3.0, 5 1/4 inch drive, and a MODEM. POC is CPT Wolf, 3-4005.

Engineer Branch Safety Office (EBSO)

MACI 2500L Fire Truck Warning. Four serious accidents have occurred recently when MACI transmissions slipped into gear during firefighting operations. Users of the MACI 2500L fire truck must lock the transmission in neutral and set the park brake before exiting the vehicle during firefighting operations. Operators must manually verify that the gear shift is locked in neutral and will not move into gear by vehicle and engine vibrations. The positive lock on the gear shift handle must click into place. Users who have experienced this or other problems with the MACI should call the EBSO office. POC is Mark Totzke, -4080.

Reserve Components (RC)

Engineer Officers Advanced Course—Reserve Components (EOAC-RC). As of 1 October 1993, RC officers have the option to complete EOAC through a two-phase course. Phase 1 consists of 208 hours of correspondence studies managed by the Army Correspondence Course Program. Phase 1 is a prerequisite to Phase 2. Phase 2 is two weeks of instruction at Fort Leonard Wood (FLW) on both combined arms operations and technical engineering foundations. The course is listed under Army Training Reports and Requirements System (ATRRS) as course #4-5-C26. Phase 1 must be completed before the 2-week resident phase; students must have a Phase 1 completion certificate when they arrive at FLW for Phase 2. Graduates receive an academic efficiency report and an EOAC diploma. The following Phase 2 classes are scheduled for FY 95:

Class	Dates
1-95	2-16 December 94
2-95	20 January - 3 February 95
3-95	10-24 March 95
4-95	9-23 June 95
5-95	8-22 September 95

POC is MAJ Rene Belanger, -4132.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

Physical Fitness

Some permanent party leaders have recently voiced concerns about the physical fitness of soldiers graduating from Initial Entry Training (IET). They say that some new soldiers arrive at their units unable to meet Army physical fitness test (APFT) requirements and unprepared for the units' physical demands. Some believe soldiers graduating from Basic Training (BT) should be required to meet Army standards for the APFT. Contrary to their belief, the training standards for IET soldiers differ from those for permanent party soldiers. The IET requirements are clearly stated in FM 21-20 and TRADOC Regulation 350-6.

All leaders must understand that soldiers report for IET at various levels of fitness. At the reception station new soldiers are assessed to determine if they have sufficient upper body strength to begin training. Male soldiers must do 13 pushups and female soldiers must do 1 pushup. Soldiers who do not meet these requirements are assigned to a fitness training unit before they attend BT. They have up to three weeks to meet the minimum requirements of 20 pushups for males and 6 pushups for females. New soldiers then begin the five phases of IET shown in the table.

Phase	Duration (weeks)	Initial Entry Training Goals and Characteristics
		Basic Training
1	1-2	- Soldiers arrive at unit. - Instill total control. - Perform diagnostic APFT. - Form buddy teams. - Require strict attention to detail. - Describe Army's expectations of soldiers.
2	3-5	- Qualify with the M16A1/A2 rifle. - Develop self-discipline and team-building skills. - Perform diagnostic APFT. - Gradually lessen total control.
3	6-8	- Increase trainee leadership. - Increase self-development. - Perform record APFT. - Deploy for field training exercise (FTX). - Complete end of course test. - Graduate.*
		Advanced Individual Training
4	9-11	- Perform diagnostic APFT. - Introduce MOS skills. - Continue common task training. - Reduce supervision by drill sergeants.
5	12-graduation (differs by MOS)	- Sustain common task training. - Deploy for tactical FTX. - Perform record APFT. - Graduate.

* One station unit training (OSUT) units participate in branch activities in place of graduation at the end of Phase III.

Be aware that physical training (PT) emphasizes the progressive conditioning of the whole body to minimize injuries. Unnecessarily injuring soldiers to achieve an unreasonable goal may cause them to miss training or be removed from training.

Diagnostic APFTs (see table) enable drill sergeants to establish physical fitness goals for each phase. Before graduating from BT and AIT, soldiers are given a record APFT. They must score 50 points per event (150 total points) to graduate from BT and score the Army standard of 60 points per event (180 total points) to graduate from AIT.

Initial Entry Training is designed to be a positive experience that new soldiers can carry to their first unit. Requiring Army standards for AIT graduates ensures that soldiers have the minimum level of fitness to do their jobs in their units. However, new soldiers report to their permanent party unit at different levels of fitness. Most, but not all, soldiers must take a final APFT to graduate AIT. Those who cannot complete the final APFT due to a medical profile and who have successfully completed a diagnostic test will be given credit for having passed the APFT. Those soldiers will have an APFT waiver attached to the APFT scorecard (DA Form 705). It then becomes the responsibility of NCOs in the unit to develop physical training that will ensure all soldiers meet and maintain the Army standards.

The PT program in permanent party units is designed by senior NCOs and should be tailored to support the unit's mission essential task list. For example, a light engineer unit will place more emphasis on road marching than a mechanized unit.

Unit PT programs require a high degree of self-motivation and self-discipline, which is very different from the highly controlled environment in IET. There, drill sergeants closely monitored the intensity level of training to ensure that soldiers trained to their maximum capacities. In permanent party units, NCOs must instill self-discipline and self-motivation in their soldiers.

A major responsibility of NCOs is to teach, coach, and counsel new soldiers. They must dedicate time and effort to producing disciplined, motivated, and physically fit soldiers who will be an effective part of the total Army team.

A soldier in the 27th Engineer Combat Battalion uses a hand-held mine detector to clear a lane on a beach so bulldozers can build a road to a landing ship tank (LST), southwest Pacific, May 1944.

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Engineer

THE PROFESSIONAL BULLETIN FOR ARMY ENGINEERS

Joint Engineer Training

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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

This issue of *ENGINEER* centers on "jointness"—the ability of U.S. Army engineers to train and conduct operations with our sister services. On the surface, operating in a joint environment seems simple enough; after all, these are other Americans whose language we speak and whose uniforms look somewhat familiar. In practice, however, jointness is very difficult. Even the professional terminology, the jargon, can be baffling. Each service has a host of minor differences in terms of training, equipment, organizations, and doctrine. The additive effect of these differences can be disruptive enough to halt operations until specific arrangements can be put into place. An ancient military toast went, "Confusion to the Enemy!" and glasses were emptied of spirits. Confusion is as debilitating as panic and, above all, we must not confuse ourselves. The true test of jointness is smooth operations from the very start with engineer units of any service who may be conducting operations together for the first time. The great cartoon military strategist, Pogo, once observed, "We have met the enemy and he is us." We cannot afford such a self-made enemy.

Our National Defense Strategy has been recast from the basis of containment of a hostile, ideologically polarized, global threat with the demise of the Soviet Union toward a "more historically normal" condition of protecting American interests on a regional basis. The work to redefine the missions of the U.S. Army and to recast the internal organization of the Army for this role is, as yet, incomplete. The engineer force structure in both the combat and construction engineering missions is subject to restructuring and downsizing. Because it is not clearly understood outside the engineer community, the construction mission is especially vulnerable to well-meaning but unwise external restructuring efforts. Engineers must not be resistant to change or hold on to cherished but obsolete policies. On the other hand, we must guard against "hollowing-out" of capabilities that history and our experiences tell us are essential. On 3 January 1914, seven months before the start of World War I, David Lloyd George, a future prime minister of Great Britain, was quoted in a London newspaper. In the interview, Lloyd George denounced the folly of expenditure on armaments and declared that the state and prospects of the world were never more peaceful. During the current recasting period in American military history, the responsible policy can only be to clearly and consistently articulate our professional judgement. Engineers must be especially clear about operational-level engineering missions, joint and combined considerations, and notional force designs.

"Training is the glue that holds the Army together." Not an original thought on my part or the first time this observation has been made, but it is constantly being proven by events in places that seemed far away from American interests just a few years ago: Somalia, Rwanda, and Haiti. Engineer soldiers must be well-trained and confident in themselves, their buddies, and their leaders to perform and survive in the diverse settings so common in today's world. In some ways a soldier's profession is more hazardous now than it was at the height of the Cold War. Since the end of the Cold War, some 700 American soldiers have received Purple Heart medals for wounds received during foreign operations.

A major "growth industry" within the military services these days is predicting the future. Many very bright people are extending the past into the future. That's always a risky business at best because only the shadows of future great events are cast into the present. "Scientific predictors" generally have a similar record as the ancients who based their statements on the behavior and entrails of birds and goats. Thinking about the future and planning for arriving at a future condition is prudent management. Basing conclusions on the certainty of a future state is imprudent and, even worse, dangerous.

In summary, exciting times. . . no doubt about it! Times filled with the innovative thinking of creative men and women and tempered by the training of engineers, who understand how the laws of physics and the strengths of materials affect human endeavors. We must learn how to achieve synergy, not rivalry, with our sister services; study our profession; and understand the political processes of our powerful democracy, while acknowledging the continuities of history. Essayons!

Engineer

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Cover photo: *Army and Marine soldiers train together on surveying techniques at Fort Leonard Wood, Missouri. Photo by Jim Anderson.*

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Photo by Jim Anderson

Joint Civil/Construction Engineer Training: It's A Reality

By Connie S. Welch

Major changes affecting engineer training are sweeping through the Department of Defense. Since August 1993, Army, Air Force, Navy, and Marine Corps personnel have worked closely to design more efficient and cost-effective ways to train initial entry service members in common civil and construction engineer (C/CE) skills. As a result of their efforts, consolidated and collocated engineer training is scheduled to begin at various locations in fiscal years (FY) 95 and 96.

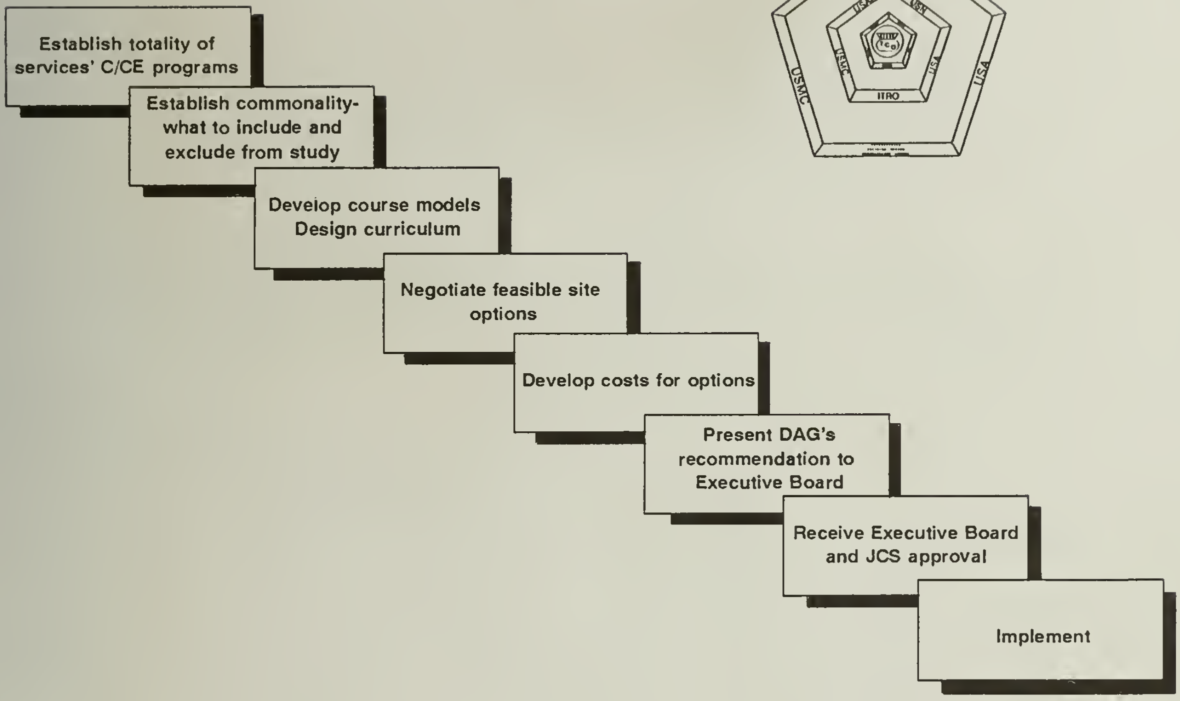
The Interservice Training Review Organization (ITRO) anticipates that benefits resulting from interservice training will include multiservice appreciation for different tactics, techniques, operating procedures and engineer equipment in addition to significant cost savings. Appreciation for other services' engineer capabilities will lead to improved interoperability and may stimulate joint construction equipment and repair parts acquisition programs.

This is a "good news" story for military engineering and our nation's defense. The complex ITRO process and program strategies described in this article are followed by the personal perspectives of committee representatives from the other services.

Changes began in August 1993, when the Civil/Construction Engineer Interservice Training Review Organization's Detailed Analysis Group (DAG) was formed at the mandate of the Joint Chiefs of Staff (JCS). The purpose of the DAG was to review the C/CE functional areas of all four services to determine if there were cost savings or training efficiencies that could be realized through consolidation or collocation. While some consolidated engineer training among the services has occurred for many years, this is the first initiative that includes all four services in common skills training.

DOD leaders realized that military reductions and diminishing resources provided the ITRO

ITRO Study Strategy


Establish totality of services' C/CE programs
Establish commonality- what to include and exclude from study
Develop course models Design curriculum
Negotiate feasible site options
Develop costs for options
Present DAG's recommendation to Executive Board
Receive Executive Board and JCS approval
Implement

study team an opportunity to design programs and train all service members with common engineer skills while attaining efficiencies and savings. The mandate by the Joint Chiefs and the ITRO Executive Board, therefore, was to expand study areas and work toward definite "go" decisions. "Make it happen!" was the edict.

The Army was designated to chair the C/CE DAG. First, Brigadier General Robert Flowers and then Brigadier General Phillip Anderson, the prior and current assistant commandant, U.S. Army Engineer Center and Fort Leonard Wood, met the challenge of this complex project with zest and a strong will to succeed.

The tone of the study was set early. Each services' representative (voting member) was empowered to make decisions and plan for their service. DAG members included Captain John Lehman, Commanding Officer, Naval Construction Battalion Center, Gulfport, Mississippi; Lieutenant Colonel Scott Smith, Commander, 366th Technical Training Squadron, Sheppard Air Force Base, Texas; Lieutenant Colonel Charles Rivenbark and (now) Lieutenant Colonel Mark Jennings, Headquarters, U.S. Marine Corps, Washington, D.C.; and Lieutenant Colonel David Boothe, Director of Department of Construction Engineering, U.S. Army Engineer School, Fort Leonard Wood, Missouri. These individuals bought into the project and led the way in making the study a success. They recognized the many benefits to be derived from consolidating or collocating engineer training, over and above the obvious possibility of cost savings:

- Cross fertilization of engineer operating procedures.
- Standardization of training techniques.
- Standardization of equipment for future acquisition and commonality.
- Improved effectiveness of repair parts when operating in a joint environment.

The DAG developed a strategy (above) to accomplish the study and mapped a course of action that included a detailed flowchart with milestones. The approach used to develop course models in the joint arena is similar to that used in a college or university. A student (service member) decides on a major (MOS), and then selects, takes, and passes certain courses to be granted that degree (certificate).

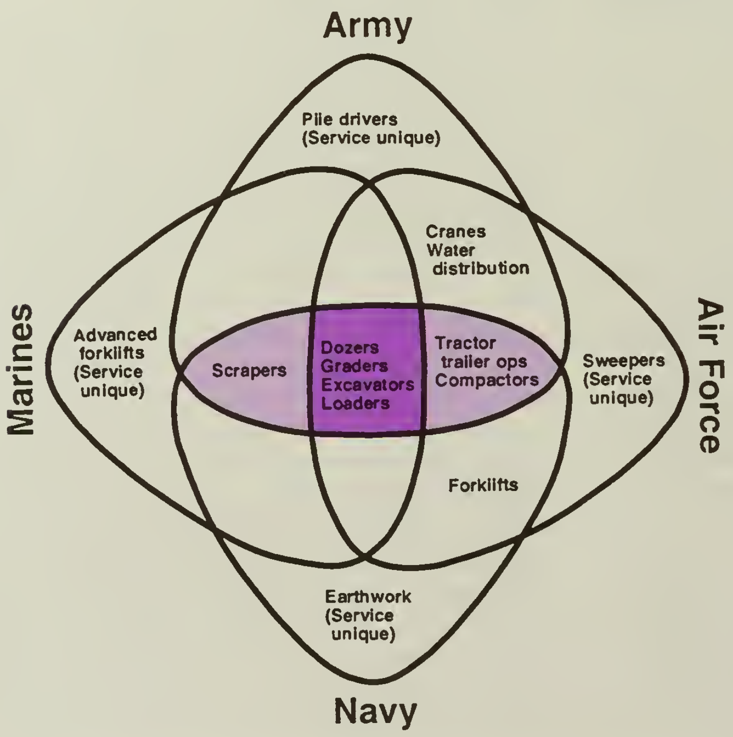
An airman, for example, must successfully complete certain training modules to become a certified equipment operator, plumber or structure specialist. As shown in the equipment operators' course model, page 4, an airman takes about six weeks of common core subjects (graders, loaders, dozers, and excavators) with the other three services. He takes tractor-trailer and compactor operations training with the Army and Navy, forklift training with the Navy, and crane and water-distribution training with the Army. Finally, the Air Force has a service-unique track only for airmen, where he trains on sweepers. The end product is a well-trained Air Force equipment operator, who has received a large part of his or her training in classes with soldiers, sailors and marines.

Approved Study Results for Civil/Construction Engineers

Type	*Current Location*	*Joint Training Location*
Equipment Operators	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Camp LeJuene, NC Fort Leonard Wood, MO	Fort Leonard Wood, MO
Engineer Technicians	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Fort Leonard Wood, MO	Fort Leonard Wood, MO
Construction Mechanics	Gulfport, MS Port Hueneme, CA Camp LeJuene, NC Lackland AFB, TX Fort Leonard Wood, MO	Fort Leonard Wood, MO Port Hueneme, CA
Structures (Carpenters)	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Fort Leonard Wood, MO	Gulfport, MS
Plumbers	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Fort Leonard Wood, MO	Sheppard AFB, TX
HVAC/Refrigeration	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Camp LeJuene, NC Aberdeen Proving Ground, MD	Sheppard AFB, TX Aberdeen Proving Ground, MD
Electrician	Gulfport, MS Port Hueneme, CA Sheppard AFB, TX Camp LeJuene, NC Fort Leonard Wood, MO	Sheppard AFB, TX Fort Leonard Wood, MO Camp LeJuene, NC
Firefighter	Goodfellow AFB, TX Memphis, TN	Goodfellow AFB, TX

The DAG met its milestone of making a recommendation for approval to the ITRO Deputy Executive Board by 15 December 1993. The recommended strategy was approved by the ITRO Executive Board and the Assistant Chairman of the Joint Chiefs on 31 March 1994.

Equipment Operators' Course Model



The DAG is now plunging into the implementation process. This difficult part of the ITRO process promises to be especially challenging because of the continually shrinking DOD budget. The major portion of the curriculum development (i.e., course design, programs of instruction, and lesson plans) has been completed and coordinated between services. Curriculum products are now moving forward for approval from each service.

In the year since the study began, much time and effort have gone into changing the joint training concept into reality—and to its current state. The approved study, now ready for implementation, will require extensive planning, coordination, and attention to detail as DAG members hammer out the many issues yet to be resolved. To prepare for full implementation next year, the DAG must resolve some complex issues, including:

Facilities

- Determine billeting standards.
- Allocate specific buildings for administration, maintenance and training that meet each service's requirements.
- Determine standards for training facilities.

Army and Air Force students extinguish a simulated aircraft crash fire at the DOD Fire Protection School.

Equipment
- Identify equipment to be shipped from one training site to another.
- Determine condition standards for equipment being shipped from one training site to another.
- Determine the most effective time to ship equipment.
- Resolve maintenance issues.

Instructor Training Courses/Certification
- Determine content and location of instructor training.
- Determine standards for instructor certification.

Performance Rating Process
- Establish an instructor rating chain. For example, determine how a Navy instructor working for an Air Force course chief will be rated on an Army post.

At this point, implementation milestones have been set and responsibilities assigned. The plan of action is aggressive and will require the continued cooperation, coordination and dedication that have gotten the DAG and its supporting cast to its current state. The end state is that joint training for engineers will begin in October 1995.

The benefits of joint training to the Army and the Engineer School are evident. As a result of this study, Fort Leonard Wood's average daily population will increase by approximately 277 students, instructors, and support personnel, and about $800,000 will be added to the annual operating budget. Additionally, ITRO brings a diverse mission to the post. Joint C/CE training provides both a one-time and recurring DOD cost savings. More importantly, the joint training process will produce the same highly trained Army soldier in every case—and in some cases a better technically trained soldier.

The ITRO study has been a great opportunity. It has allowed members of the working group to join with sister services in a common endeavor to gain engineer training efficiencies and savings. Additionally, it will place all services' engineers in a training posture that mirrors probable joint operations of the future. Actions such as ITRO are vital if the U.S. military is to train to standard within limited resources. Results of this study provide an avenue to do business better in the Department of Defense—and to provide our nation with highly skilled, capable engineers trained to operate in a joint environment.

Connie S. Welch is executive officer for the Civil/Construction Engineer DAG Chairman and technical director for the Department of Construction Engineering, U.S. Army Engineer School. She previously served as technical director for the Engineer School's Department of Instruction. Mrs. Welch holds a bachelor's degree from Southwest Missouri State University.

Joint Civil/Construction Engineer Training

An Air Force Perspective

By Lieutenant Colonel Scott L. Smith

Under the auspices of the Interservice Training Review Organization (ITRO) and the Military Training Structure Review (MTSR) project, each of the military services tasked their respective civil/construction (C/CE) functional communities to participate in a Detailed Analysis Group (DAG) study. The purpose of the study was to conduct a top-down review of C/CE technical training to assess what opportunities existed to consolidate the training presently being conducted by all branches of the armed forces. The key objective of this assessment was to determine, where feasible, how DOD could consolidate C/CE training and conserve resources to the maximum extent possible. In striving to achieve this objective, the DAG was also responsible for improving training effectiveness, maintaining or improving combat readiness, and eliminating or reducing infrastructure. This whole top-down review/study effort, from my perspective as the Chief of the USAF team component of the DAG, has been and continues to be a once-in-a-career opportunity and challenge. Read on if you are interested in knowing why.

Electrical systems apprentice training at Sheppard Air Force Base.

I have had great opportunities in my career to serve at field, major command and Air Staff levels. The icing on the cake has been the chance to serve as a squadron commander two times and for two totally different kinds of squadrons—a civil engineer squadron in an operational flying wing, and a civil engineer technical training squadron in Air Education and Training Command's largest wing. Just about the time I thought I'd been given far more opportunities to make a difference than most at my grade and experience level, I was given the task to spearhead the USAF team on the DAG.

When handed this tasking, I must admit I was a tad pessimistic. The reason was my concern about really being able to achieve "jointness." Although I had just finished the USAF 10-month Air War College resident course, where jointness was a daily motto, and although I personally think jointness is absolutely critical to DOD's success in the future, I had reservations about being able to make it happen. My main teacher over the last 20-plus years, Professor Experience, had virtually convinced me there are far more roadblocks than alternate routes available to achieve the lofty and right goal of jointness. Nonetheless, after recovering from the initial shell shock of the tasking, I could see that this was a once-

Structures training at Sheppard Air Force Base.

in-a-career opportunity. I could help breach a myriad of roadblocks and, where necessary, help build routes to take the Air Force and other services' C/CE training where it needed to go to achieve success in the 21st century.

I also knew that getting this done would be a big, big challenge! It would take a lot of smart, open-minded, nonparochial folks working together to get the job done and done right. It would also require some tough decision making by the senior leadership in all services. Last, but certainly not least, it would create demands for some choice cuts out of the sacred, shrinking money cow to really make it happen.

At the time of this writing, I am elated to report that, with the outstanding help of my counterparts in the other services and the DOD senior leadership, we have successfully seized the opportunity and we are meeting the challenge. The arduous time and effort expended by the DAG has resulted in recommendations that will consolidate and/or collocate training in the following specialties: fire protection; heating, ventilating, air conditioning and refrigeration (HVAC); electrical; utilities, structures, pavement and equipment operations; engineering assistance; and construction equipment mechanics. Training for these specialties is targeted to be spread across seven DOD installations, where the best capability and capacity already exist to accommodate them: Fort Leonard Wood, Missouri; Aberdeen Proving Ground, Maryland; Camp Lejeune, North Carolina; Sheppard Air Force Base (AFB), Texas; Goodfellow AFB, Texas; Gulfport, Mississippi; and Port Heuneme, California.

The DAG referred these recommendations to the ITRO Deputy Executive Board (DEB) early in 1994, and the DEB approved them. The recommendations were forwarded to the ITRO Executive Board, which gave its approval. As a result, the DAG is now posturing to prepare the implementation plan. In this massive undertaking, the DAG will determine how to make the training moves happen as effectively and efficiently as possible. As the DAG works through this process, I am optimistic that we will sustain the extraordinary cooperation that has made our efforts highly successful so far.

From my viewpoint, when all is said and done with this ITRO/MTSR project, all of us in the C/CE business will reap significant benefits from the long overdue initiative to train jointly. For example, we will all gain a much better perspective of what each service's C/CE folks are tasked to do and why. By training together, we will be much more ready and able to fight together when the time comes. We will make strides toward standardizing our equipment and operating techniques, which in turn will save time and money. These benefits, as well as many others, will set us—and those who follow us—up for success in the future. I challenge everyone in the C/CE business to help make this success a long-term reality by building on the jointness foundation the ITRO initiative is putting in place.

Lieutenant Colonel Smith serves as commander of the 366th Technical Training Squadron, Sheppard Air Force Base. He holds masters degrees from Texas A&M University and the University of Wyoming and is a graduate of the Air War College.

Joint Civil/Construction Engineer Training

A Navy Perspective

By Captain John Lehman

When selected as the Navy's lead for the Interservice Training Review Organization (ITRO) study on construction engineer training, I am sure that I had the same concerns and questions as my counterparts from the other services. I knew what the Seabees of the Navy could do and how they were trained, but I knew very little about the engineering capabilities of the other services. Although I had seen some of their equipment and had met some of their officers (usually at SAME conferences), I was not familiar with their training methods or technical capabilities.

The letter of appointment from the Chief of Naval Education and Training said my goal was to "improve the cost effectiveness of training" by consolidating or collocating training with other services. By doing so, we could eliminate duplication and reduce the amount of equipment and training aids required.

The letter appointed three other knowledgeable members to our team: two officers who were directly involved in Seabee training and a third, a retired Seabee master chief, who headed the Seabee Doctrine and Policy Branch at our headquarters in Washington, D.C. Fortunately, two of these team members had previous experience with the Navy's zero-based training and education review, which like ITRO, was aimed at eliminating waste and duplication within the training process.

At our first all-service Detailed Analysis Group (DAG) meeting at

Instructors check a water-depth gauge during joint Army/Navy well-drilling training at Port Hueneme, California.

Fort Leonard Wood, in September 1993, several things surfaced. First, each service had different titles for their specialty skills. Some of the "engineer" functions we identified were not accomplished by construction engineer units in other services; instead, they were accomplished by other groups, such as transportation. Each service had a foreign language of acronyms and course numbers, which frequently required translation. We each felt that our service had the "best" training program, equipment and facilities. And, all participants were willing to talk about their strengths, but nobody mentioned their training weaknesses.

After comparing student numbers, course lengths, curricula, and possible training locations, we learned that we could adjust curricula to improve the quality of training, and everyone felt more comfortable. Then came the first real test: to have our subject matter experts, all top-notch E6s through E8s who were proud of what they taught, hammer out a program that outlined which training objectives were common and which were service unique. We assumed that we could identify a core curriculum for each skill that would apply to all students. But we also knew there would be some service-unique curricula that would benefit only a single service. Questions had to be answered: Could we use the same curriculum if some services use a brand "X" bulldozer and others use a brand "Z" bulldozer? Will the ITRO courses provide enough operational "stick" time in the field? Can we do this or that?

After much discussion, all committee members were confident that the answer to these and similar questions was, "Yes, we can." Additionally, under ITRO students will receive some training on simulators or equipment that all services do not have now but expect to receive in the future. As our meetings progressed, the rationale for "why we can't" soon became opportunities to enhance training—"why we must!"

Costs were a major factor we had to consider, and we had many questions. Do we need more equipment, new training aids, more facilities, or more instructors or support facilities? What will be the one-time set-up costs for each scenario and which service will pay? Will training spaces or barracks need to be expanded? Can any of the services avoid constructing a facility they were planning to build? Will the recurring annual costs for the 13-week entry-level classes increase or decrease?

Equipment was another concern. Two services use mostly tactical equipment while the other two use mostly commercial equipment. Therefore, we had to decide if we should split the training in half or force-fit the four services together. Training together could result in more service-unique courses than common core courses and could ultimately increase costs.

The ITRO process continued and things seemed to fall into place. By December 1993, the DAG had costed, recosted, adjusted curriculum, and settled on one of twelve alternatives as the most cost effective. Under the recommended alternative, Navy Seabees will receive quality entry-level training at four centers of training excellence: the Seabee Centers at Gulfport, Mississippi, and Port Hueneme, California; Sheppard Air Force Base, Texas; and Fort Leonard Wood, Missouri. The executive board approved our alternative in March 1994, and ITRO was on its way.

Next came an even tougher challenge—implementation. Where would we start the move? This was a major decision because, in many cases, we needed to move *out* at one site in order to accommodate a move *in* from another site. Our challenge was to decide which domino to play first. Moving the administrative and instructor organizations to a base belonging to another service requires that local detachments be established, permanent change of station orders be cut, memoranda of understanding be drafted and interservice support agreements be effected with the hosts. We are making these decisions and implementing required changes now.

Just yesterday someone asked me, "Besides saving money, what will be gained from ITRO?" I didn't have to think long to reply: Since Desert Storm, the U.S. military has operated as a joint force in nearly every significant operation—whether it was a regional contingency, humanitarian relief, disaster recovery or nation assistance scenario. After the services implement ITRO, military engineers will know that each technician, carpenter, electrician, equipment operator, mechanic, plumber, engineering aid, steelworker, and fire fighter received the same basic training, regardless of their service. In the future, as the services move to a standard fleet of military tactical vehicles, we will be able to reduce parts support in the field and work more closely together. Even though each service still has its own missions and functions to perform, each service can better contribute to the overall missions of the Department of Defense because we better understand the capabilities of all the services. After all, we will all have trained together since 1996.

Captain John Lehman serves as commanding officer, Naval Construction Regiment, Gulfport, Mississippi. He holds a master's degree in civil engineering from the University of Texas, Austin, and is a registered professional engineer in Pennsylvania.

Joint Civil/Construction Engineer Training

A Marine Corps Perspective

By Lieutenant Colonel Charles R. Rivenbark (Retired)

The Marine Corps considers the Military Training Structure Review (MTSR) process, as performed under the current Interservice Training Review Organization (ITRO), as an opportunity to accomplish several goals:

- Reduce our training costs without sacrificing training quality. There should be no noticeable difference between the Marine a unit receives from the Marine Corps Engineer School and one received from the joint school.
- Use the infrastructure available at other service's facilities to reduce the Marine Corps' investment in the training effort. By making more effective use of existing facilities, we can avoid the construction of additional facilities.
- Capitalize on existing training organizations to reduce our manpower investment while training the same number of Marines.

Interservice training is not a new concept for the Marine Corps. We have been involved in consolidated and collocated training for several years. Long before the Joint Chiefs mandated the current round of consolidation efforts, Marine Corps engineers were conducting consolidated and collocated training. We conduct consolidated bulk fuel training at the Army Quartermaster Center and conduct consolidated drafting and surveying training at the Army Engineer Center. Marines now participate in consolidated explosive ordnance disposal training at Indian head, Maryland, and Eglin Air Force Base, Florida. Our crash, fire, and rescue training is collocated with the Naval Aviation Schools at Naval Air Station, Memphis. In addition, we participate, on a quota system, in other training and education, such as the Army Engineer Officer Advanced Course, materials testing course, and advanced petroleum courses.

Throughout the MTSR process, our instructions were to search for reasons to consolidate rather than to search for reasons to remain separate. The Marine Corps' engineer philosophy was that each basic course consolidated must then collocate with the associated journeyman (NCO) course. Therefore, when our engineer equipment basic courses were determined to be compatible for consolidation, we planned to collocate our NCO, senior NCO and warrant officer courses with them. The end result will be that the entire block of engineer equipment training for both operators and mechanics will be either consolidated or collocated with the other services. The alternative would be to consolidate only our basic operator and mechanic courses, leaving the remainder of the training at the Marine Corps Engineer School.

The beauty of the new ITRO procedure is the manner in which course models are constructed. Subject matter experts from all services have equal status when they create a course model. This ensures that the unique needs of each service are identified and satisfied.

In the new engineer equipment course model, the Marine Corps anticipates providing to the Fleet Marine Force equipment operators who are even more qualified than today's course graduates. As a result, the load now shouldered by individual Marine engineer units to upgrade operator licensing will be reduced. Let me explain why this will occur. Unlike the Army, the Marine Corps has only one military occupational specialty for operators of all our engineer equipment (MOS 1345). Current Marine Corps training does not license basic engineer operators at school; instead, students are licensed after they join their new unit. We use this system because the individual organizations (Marine Wing Support, Force Service Support Group, and Division) use different types of heavy equipment. After the new course model is implemented, Marine students will receive training on several types of equipment not included in our current program. Because students will learn to operate more types of equipment under the joint training concept, Marine units will have more time to concentrate on preparing for deployment and increasing readiness.

Although the "bottom line" was the primary reason for the training reviews, common sense was the rule we used during every decision-making session. Joint engineer training, as recommended during the MTSR process, will truly assist in training Marines for the Marine Air-Ground Task Force.

Lieutenant Colonel Rivenbark (retired) was the Marine Corps representative for the Civil/Construction Engineer Detailed Analysis Group. He last served as the head, Real Property Maintenance Activity Policy Section and MOS Specialist for Utilities and Engineers, Headquarters, U.S. Marine Corps. He is a registered professional engineer in Virginia and North Carolina.

Navy Seabees and the Civil Engineer Corps:

Providing Skills to the Joint Environment

By Rear Admiral Jack E. Buffington, CEC, USN, and
Lieutenant Commander Michael Bowers, CEC, USN

In today's climate, military numbers and assets are decreasing, missions are becoming more diverse, reliance on reserves in war plans is increasing and joint operations are commonplace. As this trend continues, military professionals must learn about and work with their counterparts in fellow services. This article introduces the Naval Construction Force component of joint service engineering and contingency construction.

Seabees constructing a K-Span building during Desert Shield/Storm.

Civil Engineer Corps Officers

Since 1867, Civil Engineer Corps (CEC) officers have been responsible for building and maintaining the Navy's shore establishment. For the past 52 years, CEC officers have led Seabee construction battalions in a multitude of missions. Through the years, these men and women have been recognized by the Navy and Marine Corps as engineering professionals. Today, all CEC officers have a bachelor's degree in engineering or an engineering-related field, and more than half of them have earned graduate degrees, primarily through Navy-funded postgraduate school. Additionally, professional registration is a key milestone for promotion to senior ranks within the CEC. Overall, 42 percent of active duty officers are registered professional engineers or architects, while 90 percent of O5s (commanders) and 100 percent of O6s (captains), O7s and O8s are registered.

Civil Engineer Corps officers serve in a variety of billets around the world. Analogous to some aspects of the Army Corps of Engineers, most of our officers are dedicated to stateside or overseas base facility maintenance and repair functions, or they supervise

Seabee Enlisted Ratings

Equipment Operator (EO)	Operation of construction equipment, transportation, blasting/rock crushing, well drilling, and paving.
Construction Mechanic (CM)	Construction and automotive equipment maintenance, repair, overhaul, and management.
Builder (BU)	Carpentry, masonry, reinforced concrete, and interior finish work.
Steelworker (SW)	Welding, structural steel erection, sheet metal and ductwork fabrication.
Construction Electrician (CE)	General electrical, telephone systems, and power generation and distribution.
Utilitiesman (UT)	Plumbing, air conditioning systems, water production and distribution, sanitary and waste disposal.
Engineering Aid (EA)	Engineering technician, drafting and surveying, and soils and material testing.

In a Seabee battalion, tradesmen are organized in companies by related skills. Equipment operators and mechanics, as well as the battalion's complement of vehicles and equipment, form one company. The camp maintenance/utilities construction company consists of construction electricians and utilitiesmen. Builders and steelworkers, who are vertical construction tradesmen, generally are organized together in one or two companies, based on their mission and the number of detachments. Engineering aids form part of headquarters company in the operations department.

the construction of shore facilities by independent contractors through Resident Officer in Charge of Construction offices. One-fifth of our officers serve in staff billets assigned to the Naval Facilities Engineering Command (NAVFAC) headquarters in Alexandria, Virginia; the Pentagon; or fleet or Marine Corps shore and operational commands. Thirty-four staff billets are designated as "joint" duty. There, CEC officers become familiar with engineering practices; contingency construction techniques; warfare doctrine; and philosophies and objectives of the Army, Air Force, and Marine Corps, as well as host nations. Through these educational and challenging assignments, officers digest what it means for our military services to be "interoperable."

At any given time, about 100 officers are attending graduate schools or joint service schools or serving as instructors or staff at the Naval Civil Engineer Corps Officer School and the Naval Facilities Contracts Training Center (both in Port Hueneme, California) or the Naval Construction Training Centers in Port Hueneme and Gulfport, Mississippi. The remaining 10 percent of our officers are serving in a variety of operational components of the Seabees.

Seabees

Naval Construction Battalions - the Seabees - were established in 1942. The Seabees have established a "can-do" reputation based on their motto: *construimus, batuimus:* "we build, we fight." During World War II, from Guadalcanal to Okinawa, they went ashore with U.S. Marines to build airstrips and bases. In Europe, they took part in amphibious invasions from Sicily to Normandy. Since the 1960s, Seabee civic action teams have been invited to developing nations to build and repair schools, hospitals, orphanages, utilities, roads, and bridges. Seabees in Vietnam built bases from the Mekong Delta to the demilitarized zone. In the 1970s, Naval Mobile Construction Battalions (NMCBs) began to expand a communications station on the island of Diego Garcia, in the Indian Ocean. Eleven years later, with the help of civilian contractors, Diego Garcia had evolved into a large naval facility capable of supporting both ships and aircraft.

Seabees recently participated in Somalian relief efforts and in a variety of other independent and joint service contingencies and disaster-recovery operations. During Operations Desert Shield and Desert Storm, Seabees built aircraft hangars and taxiways, ammunition supply points, perimeter defenses and camps for thousands of troops—primarily Marines. Recently, Seabees have helped in recoveries from earthquakes in California, monsoon floods in Bangladesh, hurricanes in the

Nearly 800 Seabees were involved in recovery efforts in the wake of Hurricane Andrew. Here, they are cleaning up a neighborhood in Dade County, Florida.

Caribbean and a major volcanic eruption in the Philippines.

Some 325,000 Seabees and CEC officers served in World War II. Currently 10,000 Seabees and 1,375 CEC officers serve on active duty, while an additional 1,200 officers and 16,000 reserve Seabees are integrated into Navy/Marine Corps warfighting doctrine. Until 1993, women were excluded from operational components of the Seabees. This year, however, both officer and enlisted women are being fully integrated into all Naval Construction Force (NCF) units.

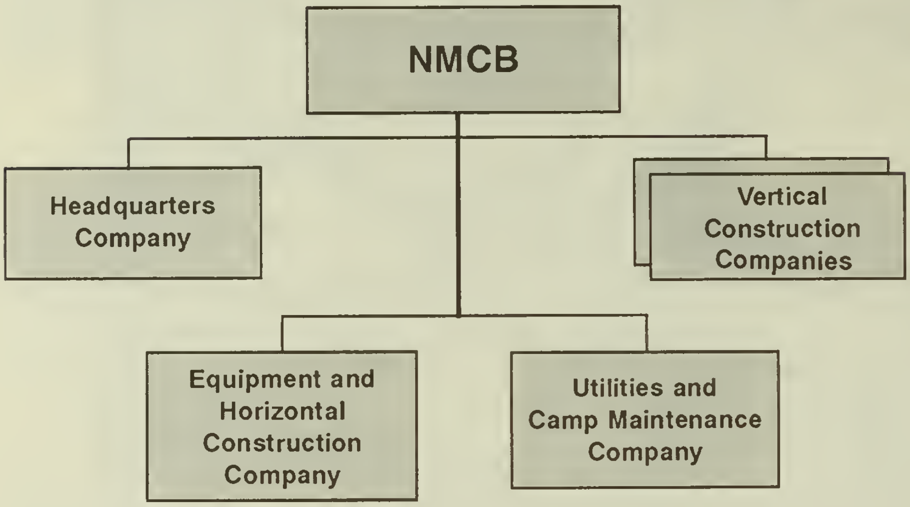
Seabee Mission

Based on current doctrine, the Seabees provide the following support to the U.S. Navy and Marine Corps and, when directed, to other services and agencies of the government:

- Responsive military advanced base construction support, including operational, logistics, underwater, shore, and deep ocean facilities construction, maintenance and operation.
- Military construction in support of Marine Air-Ground Task Force (MAGTF) operations.
- Capability to defend projects, camps and convoys.
- Amphibious assault and ship-to-shore construction support.
- Battle damage repair operations.
- Disaster control and recovery operations.
- Civic action employment.

The Seabees usually are linked with Marine Corps contingency plans, providing the Fleet Marine Force and MAGTFs extensive construction capabilities not inherent to Marine engineer forces. For example, the Seabees provide ammunition supply points, expeditionary airbases, operations buildings, port improvements or construction, warehouses, paved roads, and high voltage electrical distribution. Typical NCF projects also include follow-on enhancement work, which may have been initiated by other engineer units such as Marine Engineer Support Battalions, Combat Engineer Battalions, or Marine Wing Support Squadrons. Enhancement projects include constructing gravel or paved roads from pioneered lines of communication, completing expeditionary airfields installed by other engineer units, and installing permanent bridges to allow reuse of expeditionary bridges in the forward areas.

While working on projects, NCF units provide on-site defense for their construction sites or they join with other units as part of a perimeter defense force. NCF personnel, however, are not trained or equipped for all combat support tasks. Unlike Army and Marine Corps combat engineer units, explosive breaching of obstacles; minefield installation, marking or clearing; explosive ordnance disposal; and other combat engineer support tasks associated with direct support to ground combat elements are not normally executed by NCF units. In contrast, NCF units are highly skilled construction specialists, capable of executing general engineering (general combat service support, sustainment engineering, and survivability


Naval Mobile Construction Battalion Organization

NMCB
Headquarters Company
Vertical Construction Companies
Equipment and Horizontal Construction Company
Utilities and Camp Maintenance Company

enhancements) that exceeds the current capabilities of many other engineer units.

Seabee Organization

Naval Construction Brigade (NCB). Two NCBs are under the operational control of the Commanders in Chief of the Atlantic and Pacific Fleets. The 2nd NCB is located in Norfolk, Virginia; the 3rd NCB is located in Pearl Harbor, Hawaii. As higher echelon commands, the brigades normally are not deployed. Exercising administrative and operational control over regiments operating within their geographical area of responsibility, an NCB acts as the direct coordinator and technical advisor to fleet and component commanders desiring or requiring Seabee support.

Naval Construction Regiment (NCR). A deployed regiment directs the distribution of battalions and other NCF assets in theater, monitors task progress and quality of construction, and reviews ongoing planning and operations. During peacetime, two active training regiments are responsible for the readiness of NMCBs. They are located at the construction battalion centers at Gulfport and Port Hueneme. In addition to the two training regiments, two active duty and four reserve regiments are available to deploy to regional conflicts.

Naval Mobile Construction Battalion(NMCB). Eight active duty and 12 reserve battalions form part of today's NCF. Composed of 24 officers, 745 enlisted personnel and 230 pieces of construction equipment, an NMCB is capable of self-sufficient deployment by air or by sea within six days of notification. For rapid deployment, each battalion is equipped with an air detachment (AIRDET) of 89 men and supporting civil engineer support equipment. The AIRDET is capable of deploying independently to an austere environment on Air Force

Seabees performing runway repairs in Somalia.

Naval Construction Force		
Unit	Active	Reserve
Naval Construction Brigade	2	-
Naval Construction Regiment	2	4
Naval Construction Regiment (Training)	2	-
Naval Mobile Construction Battalion	8	12
Naval Construction Force Support Unit	-	2
Construction Battalion Maintenance Unit	-	2
Underwater Construction Team	2	-
Construction Battalion Unit	19	-
Naval Beach Group		
Amphibious Construction Battalion	2	-

transport aircraft within 48 hours notice. The battalion is also capable of forming task-oriented detachments up to one-half the size of the battalion, which operate independently in combat or low intensity conflict environments.

Adding to the self-sufficiency of the battalion, NMCBs are manned with several officer and enlisted ratings besides Seabees and CEC officers. They include: corpsmen, dental technicians, mess specialists, supply officers and various supply personnel, personnelmen, yeomen, gunners mates, postal clerks, and disbursing personnel; plus a doctor, dentist, chaplain, legalman, photojournalist, and a Marine Corps senior enlisted advisor. The battalion also has a team of skilled individuals certified in sea embarkation and air embarkation through a joint service or Air Force school.

Amphibious Construction Battalion (PHIBCB). Deployed with amphibious readiness forces, the mission of the two PHIBCBs is to provide immediate "over-the-beach" support to Marine forces. They provide a logistics link between ship and shore during amphibious operations. Personnel in an amphibious battalion are skilled in floating and elevated causeway construction, installation and operation of ship-to-shore fuel systems, and assembly and operation of self-propelled pontoon barges for cargo/equipment transfer operations. The 53 officers and 991 enlisted personnel assigned to a PHIBCB provide necessary beach improvements and camp support for the Naval support element of a joint operation.

Underwater Construction Team (UCT). The two UCTs are self-sustaining construction diving units that consist of six CEC officers and 99 enlisted personnel. They provide a wide range of underwater construction capabilities, including construction, inspection and repair of ocean and waterfront facilities, underwater battle damage assessment/repair, and underwater construction support of amphibious operations. Each UCT has three active and two reserve air-deployable diving teams plus a shore support component. UCT ONE is located in Little Creek, Virginia, and UCT TWO is in Port Hueneme.

Construction Battalion Unit (CBU). Nineteen CBUs are located at bases in the United States. Each unit is composed of one officer and 44 enlisted personnel. Peacetime employment of a CBU centers on construction and repair of shore facilities at installations where they are assigned. The CBU contingency mission, however, is to provide construction, operational, and maintenance support of rapidly deployable 250-bed or 100-bed combat-zone, disaster-relief, or low intensity conflict hospitals. When necessary, two CBUs are combined to support a 500-bed or larger fleet hospital construction mission.

Reserve Units

Construction Battalion Maintenance Unit (CBMU). Two CBMUs manned by reservists are available for recall. A CBMU consists of 7 officers and 329 enlisted personnel. Their mission is to provide maintenance (public works/minor construction) support to a forward base before or after construction has been completed. This plan allows NMCBs actively engaged in a conflict to redeploy to more forward battle areas or to another geographical region, if necessary. A CBMU also provides limited defensive warfighting capability, eliminating the need for civilian construction personnel in a combat zone.

Naval Construction Force Support Unit (NCFSU). The reserve NCFSU includes 12 officers and 202 enlisted personnel. It provides logistical and engineering support to multiple NMCBs in

"Despite the forces at work diminishing our assets and manpower...we must strive to build interservice relationships on common ground."

theater by augmenting the following mission areas: design, planning and estimating; construction material expediting/delivery; heavy equipment maintenance and repair; and long-haul transportation, paving, and concrete placement.

Peacetime Operations

Seabee battalions operate on a rotation cycle that has them operationally deployed for seven months outside the continental U.S., followed by seven months of home-port duty for training and refitting. During a 7-month deployment, battalions embark to forward deployment sites in Guam, Okinawa, Spain, and Puerto Rico. While overseas, the NMCB functions independently, under the auspices of the area commander, performing preplanned on-site construction. Projects include construction of permanent paved roads, replacement of electrical distribution systems, construction of new buildings and utilities, rehabilitation of barracks, or other such construction. On deployment, a battalion typically will send detachments on various construction missions within the operating theater. Between 13 and 100 personnel, led by senior enlisted Seabees or junior officers, deploy directly to sites such as Honduras, Panama, Cuba, Japan, Korea, and several islands in the South Pacific. On deployment, battalions emphasize construction training, command and control skills, safety, and autonomous operations. Frequently, battalions on deployment also participate in area joint exercises, such as Team Spirit in Korea and Joint Chiefs of Staff/ NATO joint-combined exercises in Europe.

Recent Joint Operations

Seabees have participated in a variety of joint service operations in the past few years. Recent examples of NCF elements in the joint arena follow:

Operation Desert Shield/Storm, 1990-91. One regiment, four battalions, one tailored NCFSU, two CBUs and one UCT deployed in support of Navy and Marine forces. In Southwest Asia, the Seabees constructed 4,750 buildings (some K-Span), aircraft hangars, six million square feet of aircraft parking aprons, 14 galleys to feed 75,000 people, and a 40,000-man enemy POW camp. They also maintained 200 miles of unpaved desert four-lane divided highway as main supply routes, erected fences and steel security towers, installed major electrical distribution systems and sanitation facilities, constructed thousands of meters of concrete decks and walls, and fabricated mock artillery pieces and tank turrets.

Hurricane Andrew Recovery, Florida, August 1992. Working with the Army Corps of Engineers and Joint Task Force (JTF) Andrew, the equivalent of one Seabee battalion from several units assisted in the recovery effort. Under the JTF, the Seabee effort was concentrated on restoring 278 schools damaged by the hurricane. In 13 days, Seabees repaired roofs, insulation systems, air conditioning, and electrical power in nearly 200 schools—the equivalent of more than $2 million in repair work.

Operation Restore Hope, Somalia, 1993: One regiment and two battalions deployed, attached to a Marine expeditionary unit commander. The Seabees worked hand-in-hand with coalition engineering units and Army, Air Force, and Marine engineers to construct encampments and repair roads, bridges, airfields and other facilities in country. CEC officers managed construction contracting support by Brown and Root via a Corps of Engineers logistics contract.

Deployed Medical Facility, Zagreb, Croatia, 1994. Since March, 34 Seabees have provided public works and minor construction support to the contingency hospital, originally set up and operated by the Army and Air Force. Due to their embark skills, a team of five Seabees are assigned to the United Nations airfield to coordinate flight-line operations. These equipment operators act as a cargo handling and manifesting unit, loading and unloading U.S., Russian, and other forces' transport aircraft.

Operation Sea Signal, Guantanamo Bay, Cuba, 1994. Two Seabee AIRDETs worked closely with an Air Force RED HORSE unit, Army Logistics Task Force 64 personnel, an Air Force Prime BEEF unit, and Marine engineers to construct migrant camps, security, and sanitation facilities for more than 40,000 Cuban and Haitian refugees.

Restore Haiti, 1994. An amphibious Seabee battalion deployed in support of a potentially aggressive over-the-beach invasion, which was diplomatically averted. Several CEC officers have mobilized for logistics contracting needs in Haiti. CEC

Navy Seabees worked diligently with the Army, Air Force, and Marine engineer units to construct tent camps at Guantanamo Bay, Cuba, for Haitian and Cuban refugees. Seabees erected additional refugee camps in Panama and on the Island of Grand Turk.

officers and a UCT team, under the direction of the JTF engineer, inspected port facilities, piers and harbor cranes to determine the extent of repairs required for continued operation support.

Joint Initiatives

Joint Publication 1, released in 1991 by the JCS, is a capstone document that guides joint warfare concepts. As stated in this publication:

"Service skills form the very core of our combat capabilities. Joint warfare does not lessen Service traditions, cohesion, or expertise. Successful joint operations are impossible without the capabilities developed and embodied in each service..."

This document further embraces the importance of interservice "team building." Fully involved in interservice teamwork, the Seabees are supportive of several initiatives aimed at improving service interoperability.

Perhaps the greatest area in which to exploit improvement is the training environment. Specifically, progress to date by the Interservice Training Review Organization (ITRO) has been promising. Soon, our construction engineer technicians will be trained at five consolidated training centers of excellence. The Seabees will host training for carpenters, builders, structures (Air Force carpenters) and steelworkers at Gulfport and mechanics at Port Hueneme. Equipment operators and engineering aids are scheduled to attend training by the Army at Fort Leonard Wood, while the Air Force is planning to train electricians, plumbers, and utilitiesmen at Sheppard Air Force Base, Texas.

More importantly, it will be increasingly crucial that our engineering officers, who will be placed in strategic positions of responsibility at unified commands, gain greater exposure to engineers of other services. Two ways in which this can be accomplished is through improved officer billet exchange programs and guest seminars at advanced engineer officer courses. Further, by participating in activities sponsored by the Society of American Military Engineers (SAME) and by developing a strong joint professional reading program, our officers will gain tremendous insight into views expressed by their counterparts and the JCS.

We must also place more emphasis on procurement and logistics. Weapons systems, communications equipment, and other equipment and parts compatibility in the field must be optimized. Interservice and theater-level working groups should continue to plan service responsibilities for long-haul transportation, chemical-biological detection and decontamination, bulk liquids storage and transfer, and development of water resources. Moreover, associating together on research and development issues offers unique economies of scale.

The Future

Joint efforts create a common perspective from which to plan and operate. Ultimately, unified operations fundamentally shape the way we think about and train for war. And despite the forces at work diminishing our assets and manpower, ostensibly making each service fight for its own resources, we must strive to build interservice relationships on common ground. We must understand each service's mission and capabilities and create doctrine for effective operations. Collectively, we need to further improve in many engineering areas—and the Seabees stand ready to move forward with the other branches of our joint team!

Rear Admiral Jack E. Buffington, CEC, U.S. Navy, is the Commander, NAVFAC, and the Chief of Civil Engineers. In April 1994, he became the president of SAME.

Lieutenant Commander Bowers serves in the Seabee Division of NAVFAC.

Avoiding
The Mine-Clearing Line Charge (MICLIC)
An Engineer's Nightmare

By Captain Frank T. Akins

10 November 1994, 1005 hours: It was a hot morning—even for Africa—and the on-going war was heating up. Lieutenant Colonel Ross Chamberlain, engineer battalion commander, received a FRAGO for the next day's mission from the brigade task force commander. According to intelligence, the enemy had emplaced a 150-meter-deep mine-and-wire obstacle directly in the path of the task force, and a bypass was out of the question. LTC Chamberlain was directed to task organize into the task force breach team and to conduct a deliberate breach in support of the brigade's offensive mission. Preparation went as planned, and every engineer company commander reported their engineer systems to be fully mission capable. The OPORD was received at 1800 hours, and checks and rehearsals were executed to standard. Simulated MICLIC firings occurred during rehearsals at a secure location that closely resembled the anticipated enemy obstacle. Wake-up was at 0245 hours, and the task force was moving by 0350 hours. When the anticipated obstacle was encountered at 0730 hours, the task force suppressed, obscured, and secured the intended breach site. Enemy forces were held at bay by well-coordinated direct and indirect fires. LTC Chamberlain's blood boiled, and he could already taste unequivocal victory. Every available MICLIC was moved forward—but they failed to fire! The task force lost momentum and began to receive withering direct and indirect fire. "We're dying out here!" gasped the task force commander over the radio. Then...silence.

◆

LTC Chamberlain awoke in a cold sweat. On leave with his family in Maine, he knew he had to go back to the battalion and take care of the "MICLIC nightmare" while there was time—before the upcoming National Training Center rotation. "We must have an effective program enforced by my chain of command to make those things work," he thought. Then he drafted this outline:

- Maintenance and Training Program
- MICLIC Malfunctions
- Tactical Assembly Area Checks
- Assault Position Checks

LTC Chamberlain drove back to his unit and called a meeting with the company commanders, the XO, the S3, the S4, the command sergeant major, and the maintenance technician, and presented his maintenance and training concept. The company commanders admitted that they lacked in-depth knowledge of the MICLIC and were not satisfied with current MICLIC training. An effective training program definitely was needed.

The battalion maintenance technician had recently called Rock Island Army Depot and had a draft maintenance plan ready for review. He reported that the MICLIC had technical malfunctions that could be reduced but not always eliminated. He would review an after-action report on the MICLIC from Operations Desert Shield/Desert Storm to ensure that all problems identified in it were addressed in his plan. The S3 would give professional development classes to officers and NCOs on the operation of the MICLIC and work with the maintenance technician to synchronize maintenance and training. The S4 ensured that the inert and live charges were ordered. He recommended that the M68 inert line charge containers remain with the unit rather be returned to the ammunition supply point because these containers have electrical connectors that can be reused for set-up and prefire checks. After several days of planning and consultation at the user level, their program was ready for trial.

Maintenance and Training Programs

The maintenance technician reported that, during motor stables, launcher and trailer maintenance were ignored until the line charge was needed. Squad leaders did not have the necessary technical manual (TM 9-1375-215-14&P, 1992 issue) or technical bulletin (TB 43-0001-36-5, 1 January - 31 March 1994 reporting period). In addition, critical parts were missing on MICLIC launchers and trailers. He called the battalion publication NCO to order the manuals. Then he met with the S3, and they agreed on the following program:

Maintenance Program

- ☐ Develop routine command-enforced maintenance checks for the launcher and the trailer, including systematic checks with an inert line charge or empty inert charge container.
- ☐ Involve leaders directly to ensure that maintenance deadline deficiencies are corrected.

Training Program

- ☐ Focus the officer and NCO professional development classes on MICLIC operation.
- ☐ Ensure that live and inert line charges are available for training; obtain empty M68 inert line charge containers to use during set-up and prefire checks.
- ☐ Reserve the range for live MICLIC training after everyone can correctly perform set-up and prefire checks.
- ☐ Develop internal checklists and closely monitor on-site maintenance and training events for the MICLIC:
  - Perform preventive maintenance checks and services (PMCS) of the launcher and trailer "by the book."
  - Use TM 9-1375-215-14&P and TB 43-0001-36-5 in garrison and the field, and perform follow-up checks to ensure that deficiencies are corrected.
  - Perform prefire checks in the tactical assembly area and in the assault position; use inert and live line charges in training.

MICLIC Malfunctions

The battalion maintenance technician called Rock Island Army Depot and reviewed the Desert Storm MICLIC after-action report, all material work orders, and TM 9-1375-215-14&P and TB 43-0001-36-5. Then he compiled the following list of known MICLIC malfunctions that he wanted to curtail or prevent:

- ☐ The arresting cable breaks when the rocket reaches its apex.
- ☐ The rocket does not fire, or it fires but does not travel far enough.
- ☐ The rocket fires but does not leave the launcher.
- ☐ The launch arm is damaged when the MICLIC is towed over rough terrain.
- ☐ The launch arm alignment pins are damaged when the MICLIC is towed over rough terrain.
- ☐ The rocket does not fire even though preliminary checks show that the entire electrical firing circuit is good. The rocket is labeled "MISFIRE" according to procedure and is shipped back to the factory; there, the rocket is tested and fires.
- ☐ The neutral safety switch gives false readings.
- ☐ The neutral safety switch plug wires are easily damaged.
- ☐ The cable routing from the MICLIC to the towing vehicle degrades the vehicle's nuclear, biological, and chemical (NBC) capability.
- ☐ The trailer is damaged when it is towed at speeds exceeding 15 mph.
- ☐ The trailer's quick-release mechanism malfunctions when it is dusty.
- ☐ The firing and rocket systems lack sufficient redundancy.
- ☐ The MICLIC cannot be fired unless the trailer is on relatively level and stable ground.
- ☐ The M34 blasting machine tests "GO" yet lacks enough voltage to fire the MICLIC.
- ☐ The fuze malfunctions.
- ☐ The safety switch assembly is cross-wired from the factory (wires are not color coded), yet checks indicate "GO."
- ☐ The entire electrical system cannot be tested without live or training linear charges.

The following checklists were developed to reduce the number of MICLIC malfunctions. The checklists, however, do not replace TM 9-1375-215-14&P, TB 43-0001-36-5, or common sense.

Tactical Assembly Area Checklist

1. Obtain the appropriate manuals:
(a) TM 9-1375-215-14&P (The 1992 issue is current).
(b) TB 43-0001-36-5 (1 January - 31 March 1994 reporting period). It has electrical check information not found in the current technical manual.

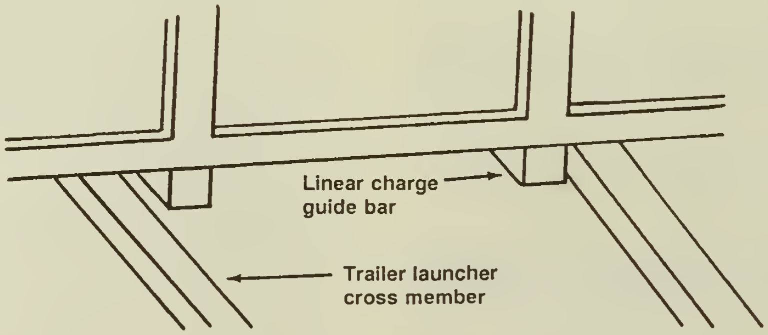
2. Configure the launcher and trailer as follows:

Launcher/NSN	Authorized Trailer
MK155 MOD 0/1055-01-203-5883	M353 only
MK155 MOD 1/1055-01-281-2770	M353 or M200A1
MK155 MOD 2/1055-01-340-6084	M353 only
MK155 MOD 3/1055-01-327-3106	M353 or M200A1

The launcher and trailer must be "married up" correctly and the turnbuckles must be secure and tight. Otherwise, the charge will jump around during towing and deployment, possibly causing a misfire. Items 4 and 5 give the correct procedure.

The M200A1 trailer must be modified; TB 9-2330-323-30 contains the necessary instructions.

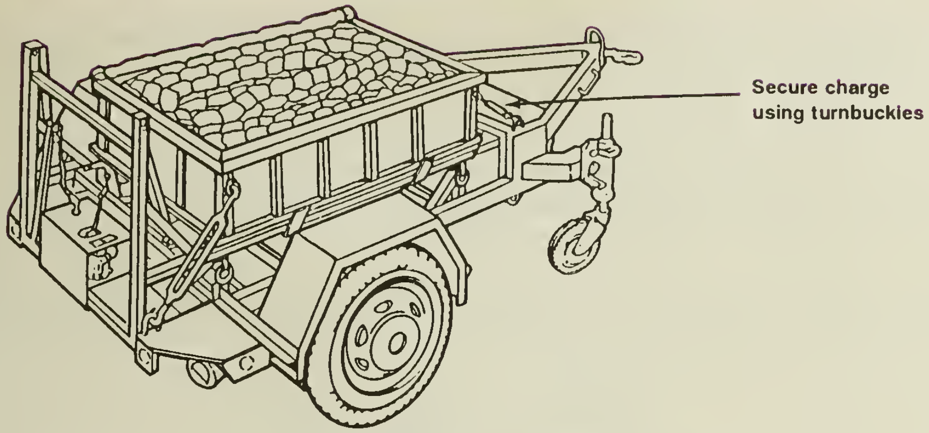
3. Position the linear charge on the launcher so the guide bars of the linear charge are between the cross members of the launcher, as shown:



4. Bolt the launcher tightly to the trailer with flatwashers, lockwashers, 15/16-inch nuts, and U-bolts.

5. Secure the linear charge to the trailer's lifting rings with all four turnbuckles. Tighten the turnbuckles, then use a 1 1/8-inch open-end wrench to tighten the locknuts on the turnbuckles. The open face of the turnbuckles should point away from the container.

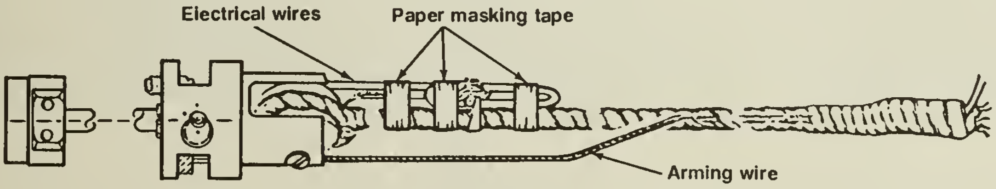
Caution: Do not secure the linear charge container to the launcher or the charge may not fire correctly (see the following illustration).



6. Check the fuze installation by feeling through the nylon sock after the launcher is on the trailer. Ensure that the electrical wires running under the sock are taped on one side of the arresting cable and that the arming wire is on the opposite side. If the electrical wires are not taped separately from the arming wire, then complete the following steps:

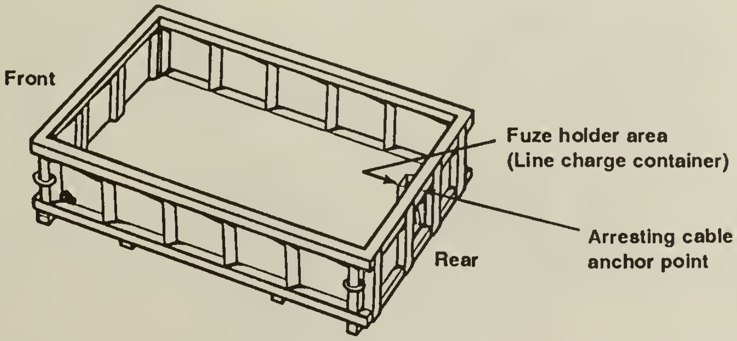
(a) Remove the hose clamp.
(b) Pull back the nylon sock.
(c) Align the electrical wires on the side of the arresting cable that is opposite the arming wire, and secure the electrical wires with masking tape.

Caution: Use paper masking tape, which will break away (not stretch) during deployment. Never use electrical or "100 mph" tape because it will stretch during deployment (see the illustration below).



7. Avoid pulling on the arresting cable when working with the fuze. Pulling may damage the shorting loop built into the end of the arresting cable. The shorting loop is a system safety feature that prevents accidental detonation of the line charge.

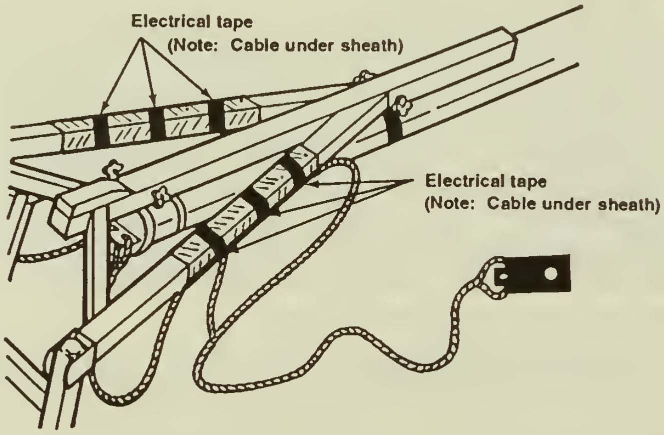
8. Secure the fuze in the fuze holder after completing the fuze installation procedure, as shown:


Front
Fuze holder area (Line charge container)
Arresting cable anchor point
Rear

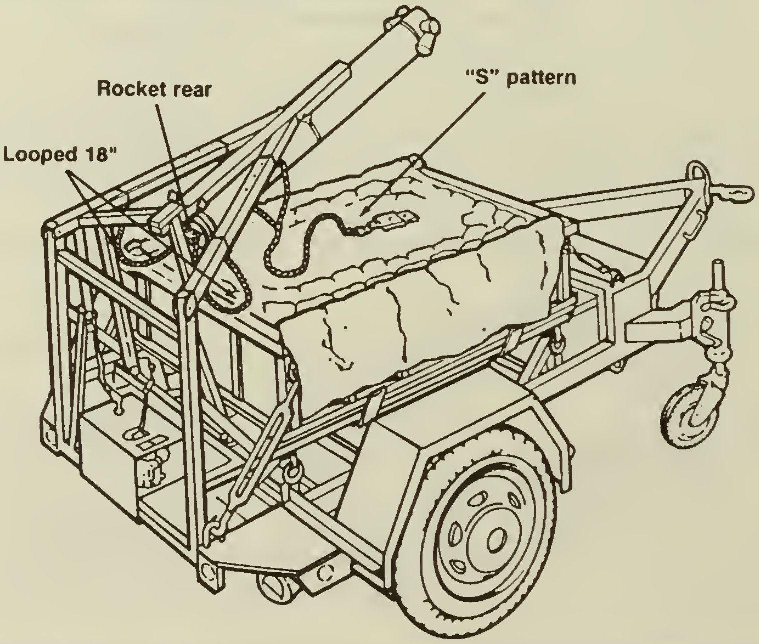
Caution: An unsecured fuze may be damaged when the line charge is deployed and result in a misfire.

9. Position the protective nylon cover on the linear charge container after the assembled fuze is installed in the fuze holder. The protective nylon cover must be peeled back from the center to install the rocket motor. The nylon cover, part of the basic issue items, should be in the launcher storage compartment. It protects the charge from dirt.

10. Loop the rocket bridle cables 18 inches and insert them under the cable sheath on the launch rail during the rocket motor installation. Use electrical tape to secure the cable under the cable sheath in three locations, as shown:



Ensure that the cable on top of the linear charge is in an "S" pattern from the rear to the front of the linear charge container. The cable sheath helps the charge deploy. Point the rocket harness connector forward (toward the minefield) and position it toward the front of the linear charge container to achieve the "S" pattern. This pattern minimizes whipping action during deployment, which may cause a misfire (see the illustration).



Caution: Handle the MK22 Rocket Motor with extreme care because the electrical lead at the rear of the rocket motor breaks easily. Always lift the rocket from the box by placing your hands around the rocket tube. Do NOT lift the rocket by the bridle cables or the electrical lead.

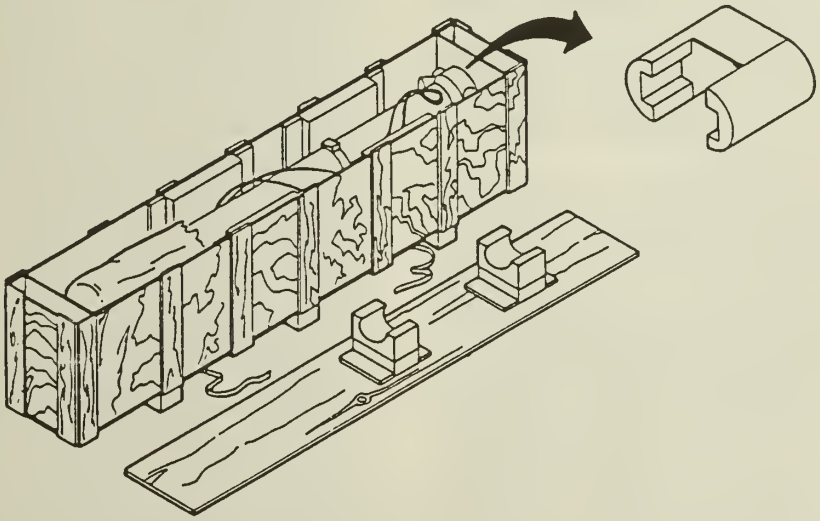
To prevent a misfire, position the rocket motor electrical lead over the end of the linear charge container; do not tie, secure, or tangle the lead to the launcher. Do NOT throw lead wires over the launching rail.

11. Protect the rocket from road shock if the MICLIC must be towed before it is fired.

(a) Lower the launch rail as far as possible to take pressure off the hydraulic system.

(b) Insert the ball lock pins in the lock position.

(c) Use the foam packing insert from the rocket motor shipping box/container to protect the motor during transport, as shown in figure below:



(1) Trim an inch from the bottom of the foam insert so it will fit between the rocket motor and the linear charge.

(2) Place the insert under the rocket motor headcap. This allows the rocket motor to rest on the foam insert instead of on the linear charge container.

Do not allow the rocket motor to hit the front of the linear charge container when the launch rail is lowered. If it does, the charge container is installed incorrectly. Refer to item 3 and reinstall the linear charge.

To avoid internal damage to the MICLIC, tow it over smooth roads whenever possible. Do not exceed 15 mph if the MICLIC must be towed over rough terrain. In wet conditions, check the brake drums for internal buildup of mud and debris. The quick-release mechanism must be free of dust and dirt to function properly.

12. Ensure that at least two M34 blasting machines are in the vehicle that will tow the MICLIC at the time of firing. As stated in TM 9-1375-203-15, Change 1, depot and division personnel must test the blasting machines before deployment to ensure that they deliver the correct amount and duration of voltage. This complete check will ensure the blasting machines function when needed.

Assault Position Checklist

Double-check the MICLIC after it is prepared for firing if it was towed. The MICLIC must be in a covered and concealed position during the check.

1. Place the ball lock pins in the raised position and put the launch rail in the firing position.
2. Open the protective cover. Allow the cover to hang over the sides of the container, but ensure that it does not interfere with the linear charge.
3. Ensure that no part of the linear charge or rocket bridle cable hangs out of the container.
4. Ensure that the rocket bridle cable is under the cable sheath.
5. Ensure that no more than 18 inches of bridle cable is looped up from the rocket motor to the cable sheath.
6. Ensure that the bridle cable lays in an "S" pattern on top of the linear charge.
7. Ensure that the fuze is securely installed in the fuze holder.
8. Insert the firing pin in the rocket motor headcap.

Reporting MICLIC Malfunctions

If the MICLIC malfunctions after performing all of the checks, report the equipment malfunctions to Armament, Munitions, and Chemical Command (AMCCOM) Rock Island, Illinois, as described in AR 75-1. As a minimum, call Mr. Eyskens, AMCCOM, at: DSN 793-7535; commercial (309) 782-7535. Or use the E-mail address: QAS1C-@RIA-EMH2.ARMY.MIL. The datafax number is: DSN 793-7136 or commercial (309) 782-7136. If AR 75-1 is not available, check with the MOS library, the ammunition supply point, or the battalion S4. If not available from those sources, call the Army "Publication Hotline": (410) 671-2533/3775. Call only when absolutely necessary.

After Preparation and Training

LTC Chamberlain pressed his commanders, and MICLIC training became systematic and effective. On 15 January, the battalion went on alert for a possible deployment to the Middle East. "It looks as if our training just might save our hides," LTC Chamberlain exclaimed to the S3. "Yes, sir!" responded the S3. "But you should see the poor performance of the field sanitation teams and the ragged condition of the mobile kitchen trailers." LTC Chamberlain glared and then roared to the S1, "I want to see those company commanders in my office now!" "It never ends," he thought as he heard boots pounding up the hall to his office. "We correct one problem and then there are two more. Just another day in the Corps."

Captain Frank T. Akins serves as Chief of Demolitions at the U.S. Army Engineer School. He is a graduate of the Engineer Officer's Advanced Course and CAS3 School.

Letter To The Editor

Reference: "Advances In Mine Warfare: Antitank Mines," by William C. Schneck, Malcolm Visser, and Stuart Leigh, ENGINEER *magazine, November 1993.*

Gentlemen:

I read your subject report "Antitank Mines" with great interest. As the chief of the German Mine Documentation Center, I am very interested in this subject area. Included in our mission is the documentation of all worldwide produced mines.

In order to prevent the dissemination of inaccurate information, permit me to make some remarks regarding the German mines and mine system.

1. Table 1: The Antitank (AT) Mine FFV-028 is produced in Sweden and was introduced into use by the Swedish Army. That mine, when introduced in the German Army, was designed as antitank mine DM 31. It is a further development [upgraded version] of the FFV-028. The difference in the DM 31 is a self-safety mechanism, seen on its exterior through a red marked casing, that is pushed out after expiration of the mine effectiveness, thereby signing the safe-state of the mine. Contrary to the FFV-028, the DM 31 can be reactivated by mine experts after the expiration of the safe-state. . A differentiation of both of these mines is, therefore, necessary and worthwhile.

2. Table 2: The AT mine PM-60 is a mine of the former National Peoples Army (East German Army - NVA) that was not taken into the permanent inventory of the Bundeswehr. All stocks will be destroyed and it should not be in your documentation.

3. Table 3: In addition to the two mentioned delivery systems, the Bundeswehr has the rocket launcher LARS (range 8 - 14 km, 180 miles) and MARS (range 40 km, 336 miles), both of which can shoot the AT mine AT-2. The documentation should be expanded to include these two systems.

With friendly greetings,

Potocnik, Captain, German Army.

Authors' Reply

The information provided by Captain Potocnik of the Bundeswehr on the DM-31, PM-60 and the German mine delivery system is most welcome. The sharing of such information between allies is important for ensuring interoperability and thereby success in future operations.

However, we believe the East German manufactured PM-60 antitank mine should remain on the list of mines that may be encountered by U.S. (and allied) forces in future contingency operations. Even though the Federal Republic of Germany is destroying the stockpile of PM-60s inherited from East Germany, this mine may still be encountered in parts of Africa and Southeast Asia, where it was exported by the communists during the Cold War.

William C. Schneck

Malcolm Visser

Stuart Leigh

Lessons Learned:
Working with the M9 ACE

By Peggy McAvenia, Sergeant First Class Tommy Simmons, and Sergeant First Class William Whitacre

The following lessons apply to U.S. Army and Marine Corps engineer units that are authorized the M9 Armored Combat Earthmover (ACE). The lessons are based on a post-fielding training effectiveness analysis (PFTEA) survey performed by the Directorate of Evaluation and Standardization in the fall of 1993.

Fielding of the ACE, which began in 1988, has been completed for most Active Component (AC) Army units and is still under way for Reserve Components (RC) units. Many units have experienced maintenance and operation problems with this vehicle. To confirm information reported by field commanders, Engineer School leaders requested that a PFTEA be performed before fielding was completed. Therefore, AC units that had employed the ACE in training or in combat for a year or more were surveyed in September 1993. The issues identified in that survey are summarized under Doctrine, Training, Leadership, Organization, Materiel, and Soldiers (DTLOMS) headings.

Doctrine

ISSUE: In the field, the ACE is being used primarily for survivability tasks, such as digging fighting positions.

DISCUSSION: The ACE was designed primarily to support mobility operations and some countermobility missions. In the field, however, engineer units use the vehicle primarily for digging fighting positions during survivability operations.

Photo courtesy of United Defense

Soldiers use a pair or ACEs to construct an antitank ditch.

FUTURE RESOLUTIONS: To decrease the amount of time maneuver units need to construct fighting positions using the ACE, the Engineer School has developed a modified (hasty) two-tiered fighting position. (See article, page 29). The school has also revised work-rate planning factors for the ACE to more accurately reflect the vehicle's diverse capabilities. The revised factors will appear in FMs 5-71-2 and 5-71-3, which are scheduled for publication in fiscal year (FY) 95. Until then, information about the planning factors will appear on the Engineer Bulletin Board System (EBBS) and in the PFTEA report. If your unit needs access to EBBS, call (314) 563-0131, extension 3-5305, for information on securing a systems operation disk.

Training And Leadership

ISSUE: Maneuver units operate the ACE beyond its capabilities.

DISCUSSION: Since bulldozers have been removed from the table of organization and equipment (TOE) of engineer support units, maneuver commanders often request that support units use the ACE to perform mobility, countermobility and survivability tasks formerly performed by dozers. Some maneuver unit commanders ignore the blade capabilities and digging sites recommended by their engineer officers. Instead, they request that operations be performed in soils or rocky terrain that exceed the capabilities of the ACE. The result is damaged vehicles and, sometimes, injured personnel.

Survey results show that many ACE operators travel with the blade in the lowered position because of the time required to fold the blade. This practice must stop! It is a serious safety hazard and may also cause extensive damage to the blade. At Fort Leonard Wood, operator training for the ACE has stressed the need to travel with the blade in the folded position since 1990. At that time, the lowered blade was identified as a factor that contributed to the deaths of two soldiers involved in a training accident.

RECOMMENDATIONS:

- Engineer officers and noncommissioned officers (NCOs) must ensure that the ACE is employed properly within its capabilities and limitations.
- ACE operators must travel with the blade in the folded position. Until an automatic blade folder is installed, units must allow for a delay of 20 to 30 minutes to fold the blade.
- Unit leaders and equipment operators must be trained to employ the equipment properly. At the Engineer School, leadership training on the ACE has been added to the Basic and Advanced Engineer Officer Courses and to the Basic NCO Course. It will soon be added to the Advanced NCO Course.

FUTURE RESOLUTION: The Engineer School should develop guidance on the types of soil and terrain where the ACE can and cannot operate safely.

ISSUE: There is a direct relationship between a unit's organizational readiness rate (ORR) and its level of operator and mechanic experience, sustainment training and degree of supervision.

DISCUSSION: Unit leaders expect to receive fully trained, journeyman-level operators from the Engineer School, who do not need supervision when they operate the ACE. They also expect to receive mechanics who are well versed on repairing ACE-specific problems. This level of training is not possible, given the time restrictions and additional training requirements in the MOS 12F and 62B Advanced Individual Training (AIT) courses. Survey results show that units with short train-up times and limited supervision of ACE operators have low ORRs. Inadequate supervision also contributes to increased accident rates. The average experience level of ACE mechanics is less than one year. While that experience level is typical for newly fielded equipment, sustainment training in the unit is required to achieve and maintain high ORRs.

RECOMMENDATION: To improve ORRs for the ACE, unit leaders must establish sustainment training programs for both operators and mechanics. They must also establish dig sites for operator sustainment training. New operators must be closely supervised for at least one or two years, depending on the frequency of task performance on the vehicle.

ISSUE: Units must provide more opportunities for operator training on the ACE.

DISCUSSION: Survey results show that 78 percent of the ACE operators have one year of experience or less in performing tasks with the equipment. The lack of operator experience results in high levels of vehicle maintenance. In the PFTEA survey, all units with short train-up times or limited training opportunities for their ACE operators had high maintenance levels.

RECOMMENDATION: It is critical that units act aggressively to develop training opportunities for their ACE operators. By doing so, they will increase their level of expertise and significantly reduce maintenance costs.

ISSUE: ACE operators who are separated from their units need close supervision by engineer leaders.

DISCUSSION: Few new ACE operators receive close guidance or supervision when they are sent to

Photo courtesy of United Defense

The M9 ACE is used to dig a vehicular fighting position.

support maneuver units. The primary reason for close supervision is to prevent accidents and misuse of the equipment by the supported unit. New operators usually lack the seasoned judgement of their supervisors and may force the ACE to perform beyond its capabilities or cause damage while operating the equipment in difficult soil conditions.

RECOMMENDATION: To ensure proper procedures are followed when the ACE is separated from its engineer unit, the equipment operator must be supervised by senior career management field (CMF) 12 personnel. The supervisor should serve as the control or point of contact for the engineer unit and the maneuver commander.

Organization

ISSUE: Efficient use of MOS 12F personnel.

DISCUSSION: Survey results show that most units use E4-grade soldiers to operate the ACE. However, when the ACE is to be separated from the engineer unit or when one ACE is operated by itself, commanders prefer to use E5-grade soldiers as the operator. Higher grade soldiers are preferred because of the degree of responsibility and experience required in those situations.

RECOMMENDATION: For more effective ACE operations, unit leaders should consider the operator's experience level when assigning personnel to engineer equipment. Use the most experienced sergeants as ACE operators. Use less experienced operators for the AVLB and CEV.

ISSUE: Table of organization and equipment (TOE) deficiencies.

DISCUSSION: ACE operators currently are assigned to combat engineer company line platoons. Because training resources are limited, they usually are not cross-trained in their MOS 12F tasks to operate the CEV and AVLB. The lack of qualified supervisors and experienced operators in line platoons adversely affects unit readiness for ACE operations.

RECOMMENDATION: Engineer commanders consolidate their ACEs in garrison to maximize the effectiveness of equipment training and maintenance.

FUTURE RESOLUTION: Engineer School leaders are studying the feasibility of consolidating the ACEs in the assault and obstacle platoons. Consolidating them in one location may facilitate effective cross training and enhance maintenance management and the employment of engineer equipment and personnel.

ISSUE: Engineer companies lack the organic capability to maintain the ACE properly.

DISCUSSION: Fielding of the ACE has increased the maintenance problems that engineer companies encounter with their combat engineer vehicles. The number of mechanics authorized to engineer companies was not increased when the ACE was fielded, which added to an already heavy maintenance requirement. Also, MOS 62B mechanics attending AIT are trained on maintenance systems not specific vehicles, such as the ACE. In spite of these limitations, engineer companies must be innovative in solving their maintenance problems. For example, units might consider consolidating their ACEs at the garrison level.

RECOMMENDATION: Units should consider using Logistics Assistance Office (LAO) technicians, who are available on most AC Army installations, to help solve maintenance problems on the ACE. Units may also consider hiring civilian mechanics to maintain this vehicle. To ease the pressure on engineer unit mechanics, assign the most experienced mechanics to the ACE. Unit leaders must support sustainment training for both ACE operators and mechanics because training is key to improving maintenance levels.

ISSUE: An alternate operator is required to safely perform some tasks with the ACE.

DISCUSSION: Survey results suggest that an alternate operator is required when the ACE is operated continuously and when the tracks and road wheels are changed.

RECOMMENDATION: Units designate and train an alternate operator to assist during continuous operations and some maintenance operations.

Materiel

ISSUE: Materiel improvements are needed for the ACE.

DISCUSSION: The ACE is now in phase III of its Systems Improvement Plan (SIP). Most of the materiel issues revealed in the PFTEA are being resolved by the SIP. Brief descriptions of materiel improvements included in phases III and IV of the SIP follow:

- Hydraulic troubleshooting: Completely rewrite all procedures.
- Final drive redesign: Redesign the oil fill indicator and improve the output shaft seals.
- Automatic track tensioner: Develop a system to automatically adjust the track tension when the operator switches between sprung and unsprung modes.
- Hub redesign
- Hardened track pin
- Automatic blade folder: Enables the operator to remotely fold and unfold the dozer blade from the crew compartment.
- Steel dozer blade
- Actuator mounting rings: Provide a stronger mounting point.
- Bowl floor access plates: Provide better access to front actuators for troubleshooting and maintenance.
- Hydraulic test points: Reduce the need to connect and disconnect hydraulic lines when troubleshooting problems. Move the test points to more accessible locations.

RECOMMENDATION: The Engineer School continue to implement the SIP program. The Tank Automotive Command continue to develop an updated logic tree hydraulic troubleshooting chart.

ISSUE: ACE operators and maintenance personnel lack reference materials for the vehicle.

DISCUSSION: The current (1986) 12F STP does not contain tasks for the ACE. Other publications frequently are not distributed at the operator and maintainer levels, where the work is performed.

RECOMMENDATIONS: Leaders must provide ACE operators and mechanics access to current manuals. Also, units must provide copies of publications such as the M9 ACE *News and Views* to operators and mechanics.

FUTURE RESOLUTION: The Engineer School is developing a new MOS 12F Soldiers Training Publication (STP), which is scheduled for publication in the 1st quarter of FY 96. Sections of the draft publication pertaining to the ACE will be placed on the EBBS by December 1994.

Soldiers

ISSUE: The ACE lacked developmental considerations for Manpower and Personnel Integration (MANPRINT) issues.

DISCUSSION: The ACE was developed before the MANPRINT program was implemented; however, future modifications of the vehicle will address new and unresolved MANPRINT issues. Some examples are described in the previous Materiel section.

FUTURE RESOLUTION: Issues identified during this PFTEA survey indicate that problems arise when aggressive user input and front-end analysis of potential MANPRINT-related concerns are lacking. The PFTEA also clearly shows the value of the MANPRINT program. Future acquisitions must identify and resolve MANPRINT issues early in the materiel-acquisition process.

Peggy McAvenia is an instruction systems specialist with the Directorate of Evaluation and Standardization, U.S. Army Engineer School (USAES).

Sergeant First Class Tommy Simmons is a combat development NCO with the Directorate of Combat Developments, USAES.

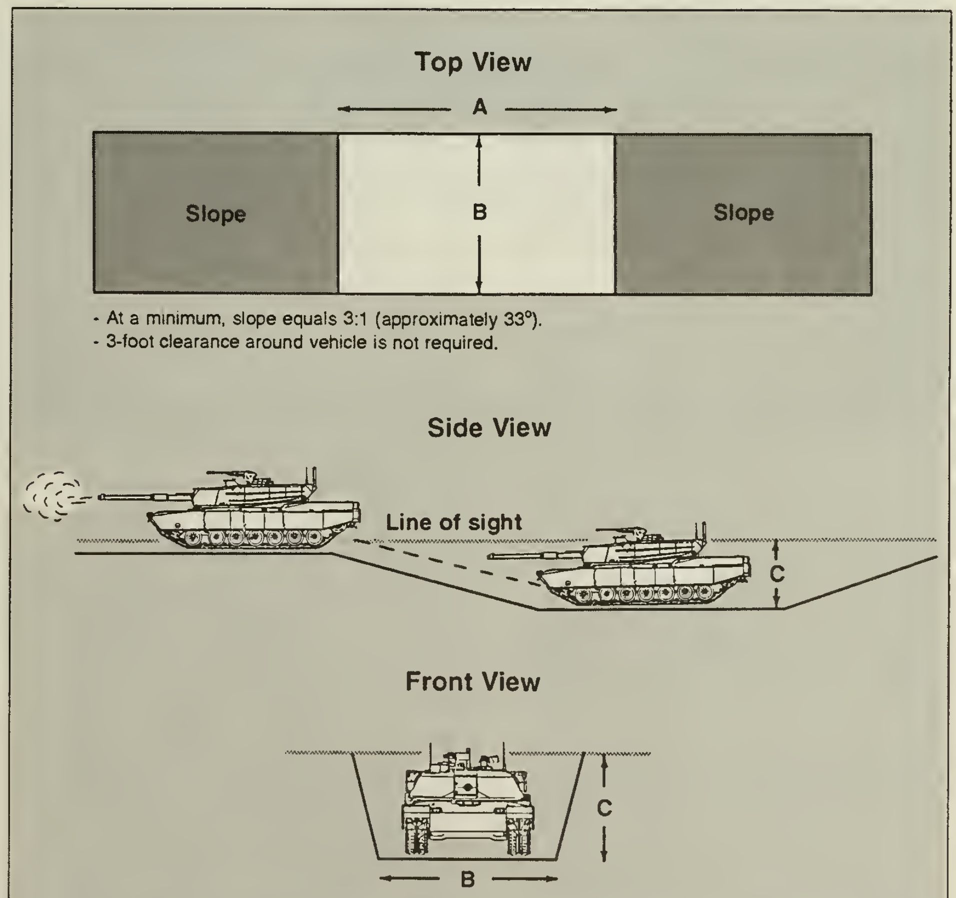
Sergeant First Class William Whitacre is a senior training developer with the Directorate of Training, USAES.

ENHANCING SURVIVABILITY OPERATIONS

By Major George DeMarse

Current Army doctrine stresses the importance of having balance and a range of options to be successful on the battlefield. As battles are fought, combatant forces are required to attack or defend in a deliberate or hasty fashion. The engineers' ability to support the maneuver mission is primarily influenced by this basic nature of combat—attack or defend. Regardless of the engineer function, our ability to contribute to the maneuver mission hinges on the ability to provide options that maximize our engineer capabilities.

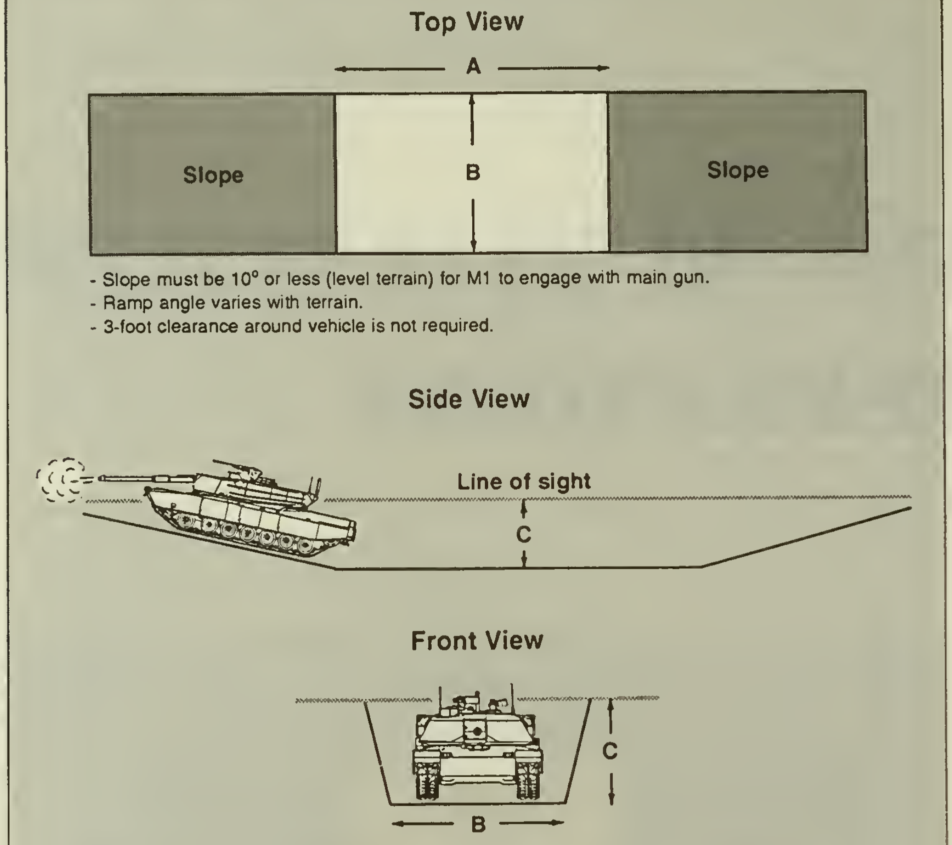
The following information explains and clarifies recent changes in U.S. Army survivability doctrine. To provide additional flexibility in survivability operations, the Engineer School has developed two hasty fighting positions (Figures 1 and 2). In developing these positions, the primary intent is to enhance engineers' contribution to defensive operations and to best utilize survivability assets on the battlefield.



- At a minimum, slope equals 3:1 (approximately 33°).
- 3-foot clearance around vehicle is not required.

	Dimensions (feet)		
	A Length	B Width	C Turret Depth
M2	26	16	10
M1	32	18	9

Figure 1. Modified Two-Tiered Hide Position



- Slope must be 10° or less (level terrain) for M1 to engage with main gun.
- Ramp angle varies with terrain.
- 3-foot clearance around vehicle is not required.

	Dimensions (feet)		
	A Length	B Width	C Turret Depth
M2	26	16	10
M1	32	18	9

Figure 2. Modified Two-Tiered Fighting Position

In combat, time is critical, and planners template it based on predictions concerning the terrain and enemy and friendly forces. Defensive operations require the defender to predict where and when he expects to encounter the attacker. Battlefield preparations in the defense follow an evolutionary process. As time permits, units conduct defensive preparations and continue to improve their battle positions. Vehicle fighting positions evolve from hasty to deliberate as the situation develops.

As a unit transitions to a defensive operation, the engineers usually begin to construct hasty positions in preparation for counterattacks and unexpected enemy actions. Combat engineers support this phase of the defensive operation primarily by concentrating their effort on the enemy's most likely avenue of approach. Initially, M9 ACEs (ACEs) are used to construct hasty positions forward. Combat engineers concentrate on preparing hull defilade and modified two-tiered hide and fighting positions, which are constructed based on METT-T.

For example, a task force commander decides to array his forces as depicted in Figure 3, page 31. Based on METT-T, he positions a maneuver company team on the southern flank to overwatch the engagement area. The task force engineer recommends that company teams in the south and the center (A and B) receive priority for survivability support. Therefore, the ACE operators begin to construct hide positions to protect those units from indirect fires and observation. The task force staff war-games the engagement area fight and expects it to last about 4 minutes. The company team in the south initially fights from their modified two-tiered hide and fighting positions, maintains a proper stand-off, and subsequently fights in sector until the enemy is destroyed. It is given specific engagement and target criteria to take the best advantage of the modified two-tiered positions. The commander designates a break line to prevent a decisive engagement.

The company team in the north (C) has suitable natural cover and concealment; it requires minimal blade effort. The company in the center requires extensive survivability effort. They need ACEs to construct modified two-tiered positions for temporary protection until dozers arrive from corps to complete the deliberate positions. Based on the war game, the company in the center can expect to receive the brunt of the attack. Those soldiers are expected to maintain the fight while the other companies maneuver and fight the enemy in depth.

An important consideration for the commander is the interrelationship between the fight and the survivability plan. Time is always a constraining factor. If soldiers can save 30 minutes or more on constructing each vehicle position, or if they can take advantage of the terrain and eliminate the need to construct some positions, then they can maximize their ability to survive and fight in a mobile or area defensive battle.

The modified two-tiered hide and fighting positions are

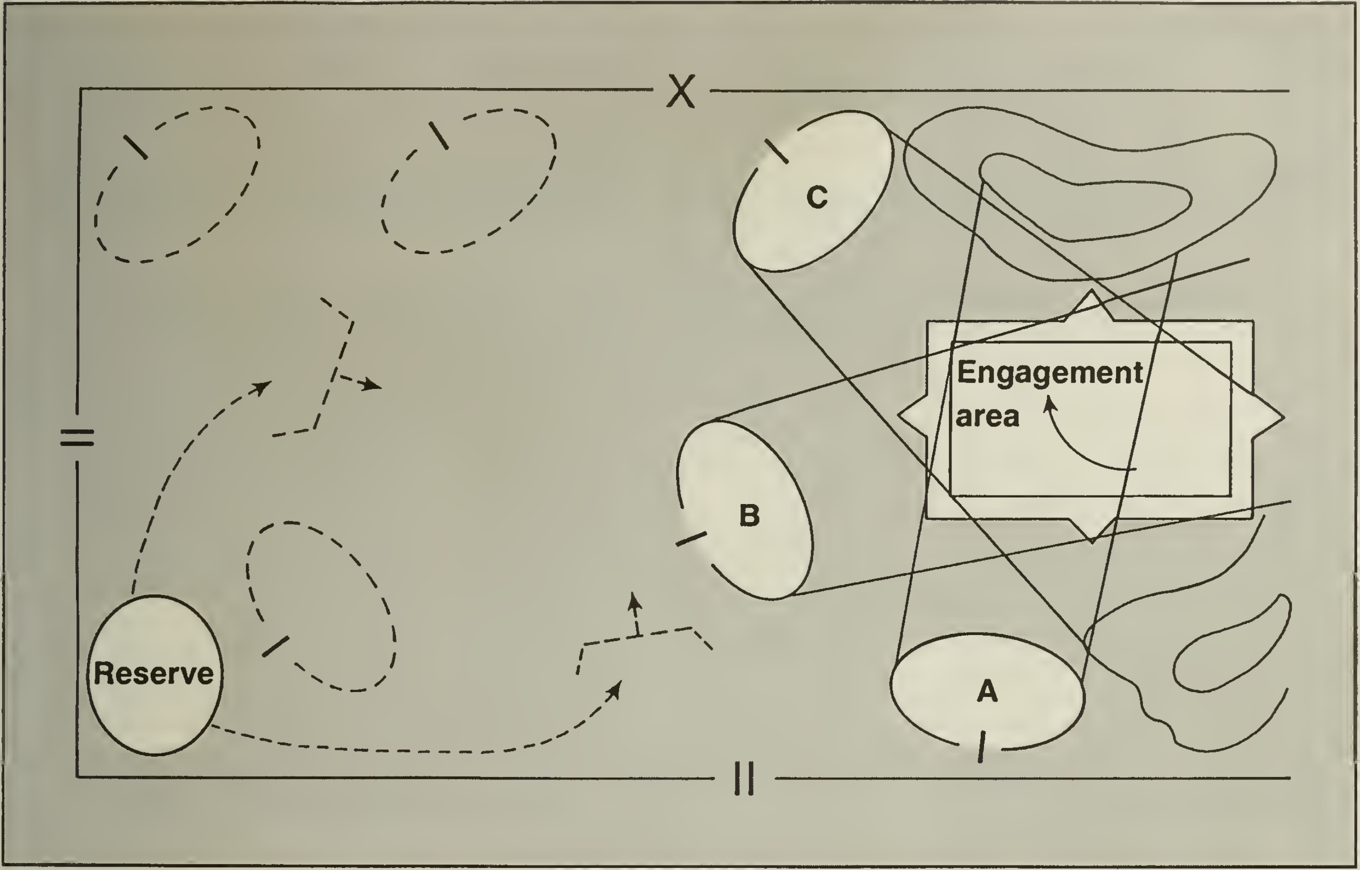


Figure 3. Task Force Defense

designed to help units take maximum advantage of the time and equipment available to them. **The hide position** (Figure 1) is most useful in situations where the friendly vehicle can engage the enemy from a flank or inconspicuous position. It is not designed to protect the vehicle while it fires. As the crew acquires the target, the vehicle moves out of its hole to engage the enemy target. When the engagement is finished, the vehicle can either return to its hide position or maneuver against the enemy.

The modified two-tiered fighting position (Figure 2) provides both a hide position and a fighting position for the vehicle. This position is most useful where the natural slope of the terrain allows the vehicle to effectively engage its target. The vehicle remains in the hide position until the target is acquired; then it moves to the forward slope of the position to engage enemy targets.

Engineers cannot rely completely on two-tiered, deliberate fighting positions while preparing for defensive operations. The modified two-tiered positions described above provide options that take advantage of the terrain and are well suited for an engagement area fight. Engineers must understand the capabilities of the ACE and employ it accordingly. The ACE is best suited to construct hasty fighting positions. Dozers, provided by corps, will come forward and construct deliberate fighting positions. As defensive preparations mature and evolve, engineers must construct and improve survivability positions by employing a combination of dozers and ACEs.

Engineer survivability doctrine, like defensive operations, evolves to create the best conditions for success on the battlefield. Engineer soldiers and equipment are fully capable of executing the overall engineer mission. Engineer leaders must consider the aspects of METT-T, recommend appropriate options, position engineer assets at the right time and place, and supervise execution of the plan. By employing the added survivability positions described above on the battlefield, engineers can provide options that better support the defense as it progresses from a hasty to a deliberate operation.

Major George DeMarse is the senior writer/instructor at the Engineer School. He previously served as a task force engineer trainer and engineer battalion staff trainer at the National Training Center. Other assignments include platoon leader, executive officer, and company commander in the 4th Engineer Battalion, Fort Carson; and assistant S3, 23rd Engineer Battalion, 3rd Armored Division. Major DeMarse holds a masters degree in business and is a graduate of the Command and General Staff College.

Maintenance Operations:

Triumphant March or Swan Song?

By Sergeant First Class Thomas Moeller

Maintenance is easy. Maintenance operations are difficult! The first rule of maintenance is - "If it's not broke, don't fix it." Maintenance operations have no simple rules, only complex solutions. Maintenance is performed on equipment—trucks, tanks, radios, weapons, and aircraft. Maintenance operations include every soldier, every activity, and every asset of the unit. They are affected by every environmental factor imaginable—time, money, personnel, weather, facilities, command climate, etc.

Effective maintenance operations begin with a plan that incorporates doctrine, training, leader development, organization, material, and soldiers (DTLOMS) to the fullest extent to reach specific objectives. The plan becomes dynamic and evolutionary. It begins with soldiers and requires each soldier's willingness to do what is right for the unit. The commander's most important roles are to create that willingness and to focus the will of the entire unit on maintenance.

Thomas Peters and Robert Waterman, in their best-selling book *In Search of Excellence*, identified one characteristic common to successful companies: All members of the organization understood what the company, as an organization, valued. Arguably, what is valued in an engineer organization could be many things. I submit that for engineer units to accomplish their mission (their reason for existence), properly performed maintenance is of the most value. Maintenance in some units is like a bad habit—everyone seems to be trying to break it! In other units, soldiers try to forget it exists. But in units that have good maintenance values, mission accomplishment is easily achieved.

Soldiers

Today's maintenance soldier has a more demanding job than ever before. Fielding new equipment, aging on-hand equipment, fewer dollars, fewer personnel, and fewer units are facts of life. The current focus on deployability has become a driver not a goal. New personnel arrive with fewer basic skills. The complexity of new diagnostic equipment means on-the-job retraining for the "old hand." CD-ROM manuals and ULLS computers create a "future tech" environment that is conducive to instant information but not instant maintenance. And equipment readiness rates must be maintained or commanders and units are subject to pressures not experienced since the days of Zero Defects. "We've done so much for so long with so little, we can do anything with nothing!" Have you ever heard that before? As a saying it is cute. As an attitude it is revealing. As a commander's expectation it is unrealistic.

There are deeper problems in that philosophy than unrealistic expectations. It assumes that maintenance is only the motor sergeant's responsibility. It does not support an equal distribution of work. It causes serious morale problems. And, it usually interferes with maintenance plans. Good maintenance isn't something that happens during the night, after all the troops go home (night shifts are seldom effective), nor does it happen overnight (unlike UPS deliveries).

Maintenance is a full-time mission and should not be attacked without an OPORD or maintenance plan. A proper mental attitude—knowing what is valued—is necessary when preparing for any mission.

Attitude adjustment begins with leaders. Their willingness must be apparent and contagious, and their values must coincide with those of the unit. Attitudes are reflected in words: Mechanics are not "grease monkeys." The motor pool is not a "shade tree operation." Nor is it the local auto dealership with drop-it-off-by-9-and-its-ready-by-4 service. Attitudes are also reflected in actions: The motor pool is the place where a unit is built and trained while maintenance is performed. Each task is an intrinsic part of a complex and comprehensive maintenance plan (OPORD), designed to have everyone contributing, with specific phase lines to cross at directed times. It is everyone's mission to keep the world's best equipment running and ready.

Training

Unit personnel must work as a team to keep their equipment operational. That includes all equipment, from the smallest hand tools to the largest rolling stock, from shovels and wheelbarrows to dump trucks and cranes. When equipment is due a scheduled service, the entire team must be involved to ensure that it is completed on time and to standard. Each soldier plays a vital part in the overall scheme. Maintenance is everyone's job, not just the equipment operator or personnel in the motor pool.

The equipment operator must participate at the scheduled service to ensure that "his" equipment receives the best service possible. The newest team member is there to assist and learn, so that one day he or she can become a top-notch, maintenance-conscious operator. Other team members are there because their presence builds pride and esprit de corps. Leaders are there to ensure that everything runs smoothly and to teach and set an example. Good maintenance can't be performed from the platoon command post or the snack bar; it requires every leader's presence. Everyone needs to crawl under, over, and around the equipment.

The most demanding PT I ever experienced was an activity called *The Maintenance Derby.* We crawled under, over, and around every piece of equipment in the motor pool. We had to locate certain U-joints, bleeder valves, grease fittings, frame members, and the like on every piece of equipment in the unit, and we were timed and scored in the process. The results opened some eyes!

Maintenance is training and must be conducted the same way: focused, interesting, challenging, and free from distractions. Every soldier must be trained on the new equipment. The current levels of sophistication found in on-board computers and diagnostics, "smart" engines, and other state-of-the-art automotive features make equipment training a challenge. Units must invest in training opportunities seldom envisioned before. Leaders should consider innovative incentives, such as allowing mechanics to wear ASE certification patches on coveralls worn in garrison.

Maintenance takes a lot of effort. It's not magical! It's not an illusion, and it doesn't happen with smoke and mirrors. Motor sergeants keep nothing up their sleeves, nor can they pull rabbits out of their BDU caps. Maintenance activities, from daily PMCS sessions to periodic services, must be scheduled and religiously followed. If other missions must take priority, they must be the exception because, sooner or later, the absence of proper maintenance will tell the tale.

Leader Development

If ingrained maintenance values are the foundation of any program, then leader development is the cornerstone. Did you ever see a sergeant carrying around the last three years' issues of *PS Magazine* during motor stables? No, of course not! But, did you ever see an NCO with articles on every piece of team equipment, clipped from the last three years' worth of *PS Magazine*, neatly indexed in a dog-eared, well-worn pocket guide? And he was using the guide to supplement maintenance being performed by team members gathered around the equipment. Did you ever see an NCO pull out an electronic notebook and refer to it for maintenance tips he had cached in digits for display on a backlighted LCD screen? If you have, then you've seen leadership you should emulate.

Training, seminars, and conferences conducted (often free of charge) by commercial manufacturers provide access to new ideas and techniques. Attending a local trade show or reviewing the latest trade magazine may reveal techniques of significant importance and result in saving time and money. Maintenance seminars should be offered at functions like the Senior Engineer Leader Training Conference (SELTC), and special seminars should be conducted during warrant officer and advanced NCO courses.

Organization

Fixing the number of mechanics authorized in a unit is an impossible task for a commander, even if that piece of our organization is broken. That task must be performed by the Engineer School leadership. But, commanders can supplement their maintenance organization, ensure that operators are qualified on equipment as a part of unit licensing procedures, and prevent operator hopscotch—the senseless moving of operators from one piece of equipment to another.

Materiel

Maintenance plans must integrate the operational use of supporting elements—wreckers, welders, contact trucks, and common tool sets. In addition to securing and using tools provided for maintenance,

(Continued on page 43)

Sand Grid:

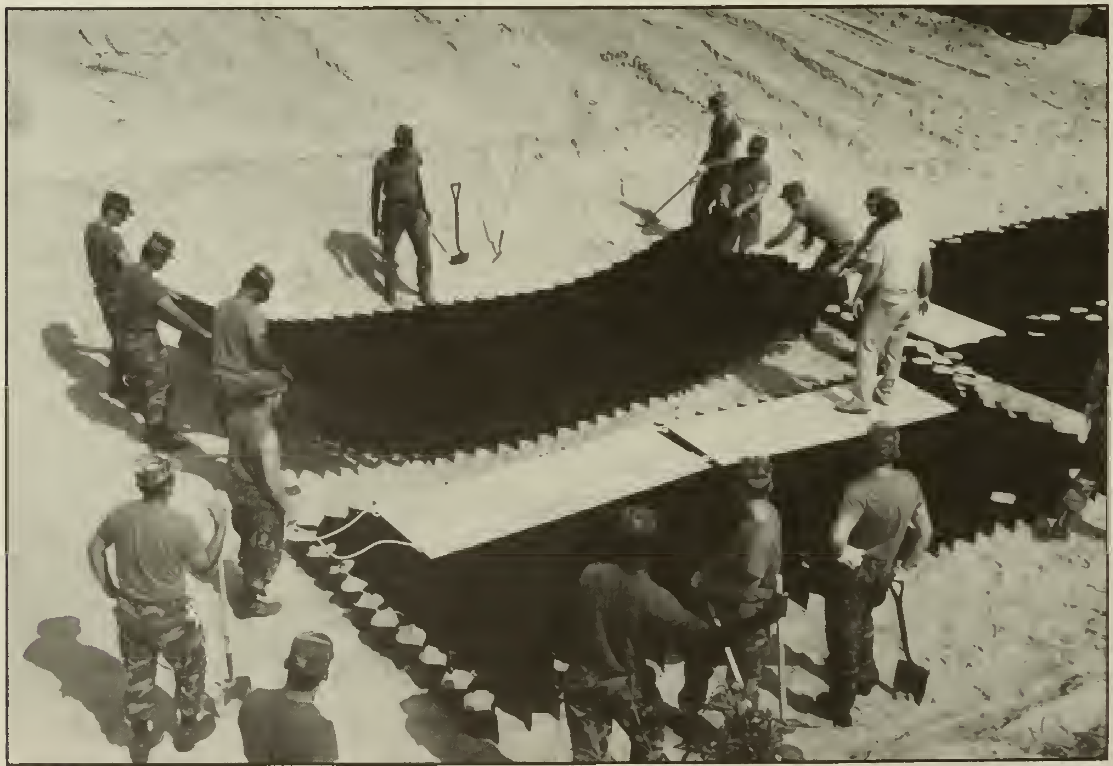
A Multipurpose Construction System

By Sergeant First Class Donald H. Purinton and Sergeant First Class Roger L. Harrison

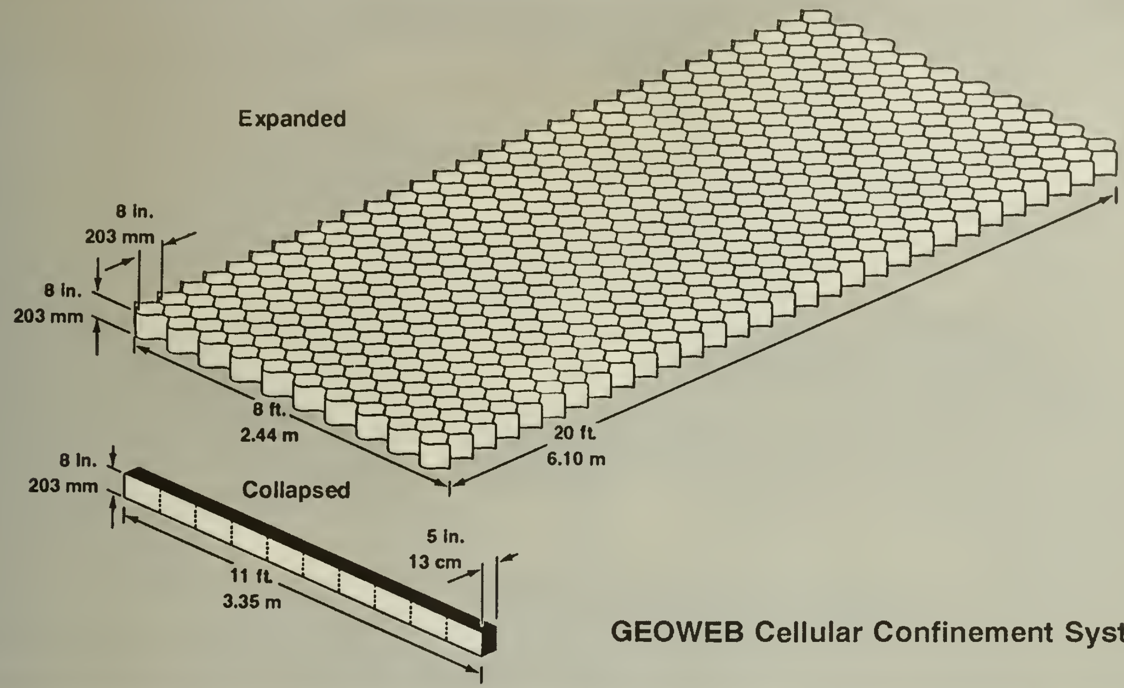
Military engineers build many types of structures. While a wide variety of construction materials are available, a geosynthetic called *sand grid* has been the most tested and proven. Although often overlooked by Army engineers, sand grid is an excellent method of field-expedient construction. It is made from high-density polyethylene and is used to confine and compact granular soils such as sand during the construction or repair of roads, airfields, field fortifications and other expedient structures.

Development

Sand grid, known commercially as Presto GEOWEB Cellular Confinement System, was developed at the U.S. Army Waterways Experiment Station (WES), Vicksburg, Mississippi, during the late 1970s in a cooperative research effort between the U.S. Army Corps of Engineers and the Presto Products Company, Appleton, Wisconsin. The original concept involved confining and compacting sand or sandy soils in interconnecting cellular elements, called grids, to produce a load-distributing pavement base layer. The resulting design is honeycomb-like in appearance. When filled with sand, the grid can be used to expediently construct pavement structures in areas with poor trafficability. The fill material can be in-place or locally borrowed, poorly graded sands found almost anywhere in the world.



Road construction with sand grid proceeds quickly. Here, soldiers are expanding and emplacing sand-grid sections at Fort Story, Virginia.



GEOWEB Cellular Confinement System

Art courtesy Presto Products Company

Availability

Sand grid sections (National Stock Number 5680-01-198-7955) are expendable Class IV supply items that cost $181 each. The plastic grids are available in 11-foot by 8-inch by 5-inch collapsed sections that weigh 110 pounds each. When fully expanded, the sections measure 20 feet by 8 feet by 8 inches. Sand-grid construction is very economical, costing about $1.50 per square foot.

Sections of sand grid are palletized for deployment and are delivered in 3,000-pound pallets that contain 25 collapsed sections. One M872A1 40-foot trailer load of pallets contains enough sand grid to construct one-half mile of 16-foot-wide road. The sections are easily dismantled and collapsed for reuse.

Uses

Sand grid is easy to use. And the basic construction procedures are the same for all of its many uses: expand and emplace sections, fill with soil, and compact.

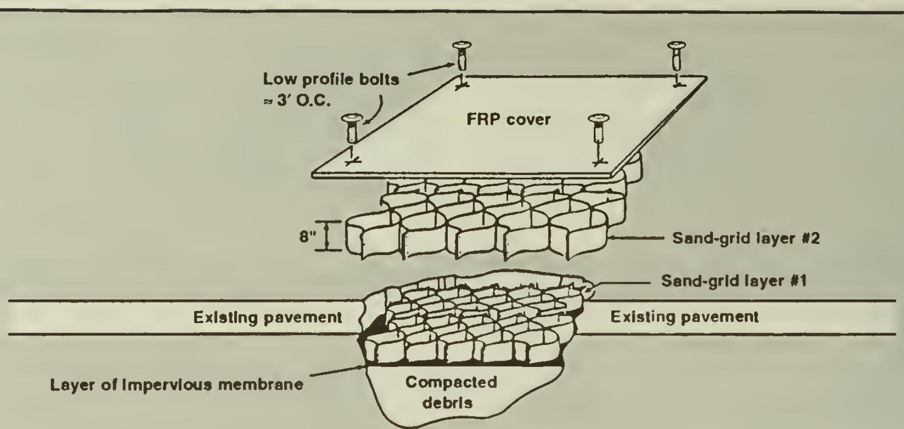
Expedient Road Construction. Theater-of-operation road construction initially provides only a trafficable surface. These roads are built to accomplish a specific mission in the most direct and efficient manner possible. Designs are simple, require minimum skilled labor and use local materials whenever possible. In many theater situations, sand grid meets these construction requirements.

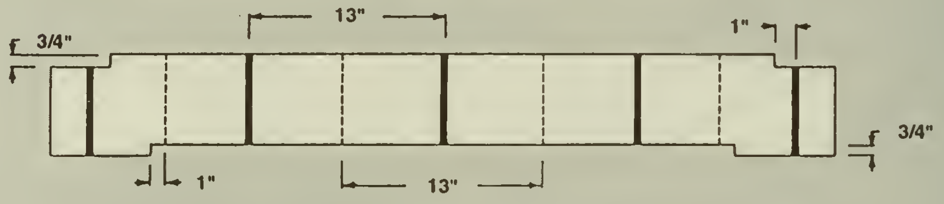
Sand-grid road construction greatly improves wheeled vehicle trafficability over sand and sandy soils. A squad-sized work crew can quickly construct a sand-grid road using scoop loaders, light bulldozers and vibratory compaction rollers. The use of rough-terrain forklifts; water distributors; asphalt distributors; long-handled, round-point shovels; and 8-foot by 4-foot by 3/8-inch sheets of plywood can increase the effectiveness and speed of construction.

Sand grid does not hold up well under tracked vehicle traffic. Tracked vehicles, however, have good trafficability through loose or cohesionless soils and can use shoulders outside of the staked right-of-way. To allow for tracked vehicle traffic, mark off a lane parallel to and near the sand-grid road. If tracked vehicles must cross the sand grid, protect it by placing a layer of gravel at the crossing.

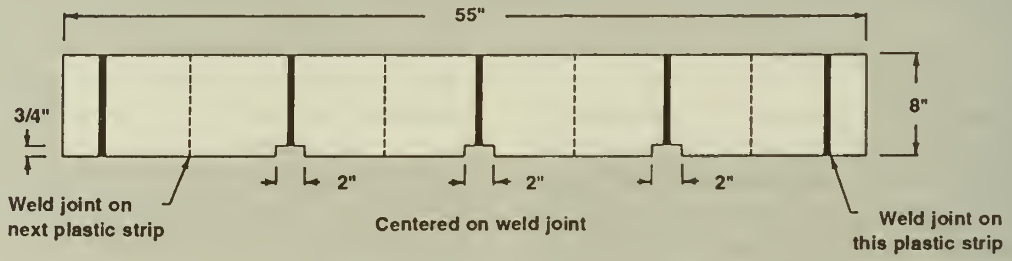
Airfield Damage Repair. Following enemy attacks, engineers must repair airfields quickly, using the most expedient methods of airfield damage repair (ADR). The sand-grid method, using the GEOWEB Cellular Confinement System with a fiberglass reinforced polyethylene (FRP) matting cover, provides a suitable runway surface. It enables engineers to repair bomb-damaged runways quickly and efficiently.

The ADR kit used to repair bombed runways measures 18 1/2 feet by 7 feet by 19 1/2 inches. It contains eight 20-foot by 8-foot by 8-inch sand-grid sections, weighs about 5,310 pounds, and contains enough materials and equipment to repair a 25-foot bomb crater. The kit is air-transportable and can be air-dropped. Repair crews can adjust sand grid to crater dimensions simply by cutting and piecing





Center strips for notched grid


55"
8"
3/4"
2"
2"
2"
Weld joint on next plastic strip
Centered on weld joint
Weld joint on this plastic strip

End strips for notched grid

sections together. Sand grid with an FRP matting cover can withstand 500 F-15 sorties, 200 C-141 sorties, or 300 C-130 sorties.

The resources required for ADR depend on the amount and type of damage, equipment and personnel available, materials on hand, and soldier expertise. As a general rule, one platoon-sized work crew for each bomb crater can quickly and efficiently repair a damaged airfield.

Field Fortifications. Survival on the battlefield depends on the quality of protection provided by fighting and protective battlefield positions. Field fortifications are designed to protect personnel, weapons systems, vehicles and equipment while deceiving the enemy.

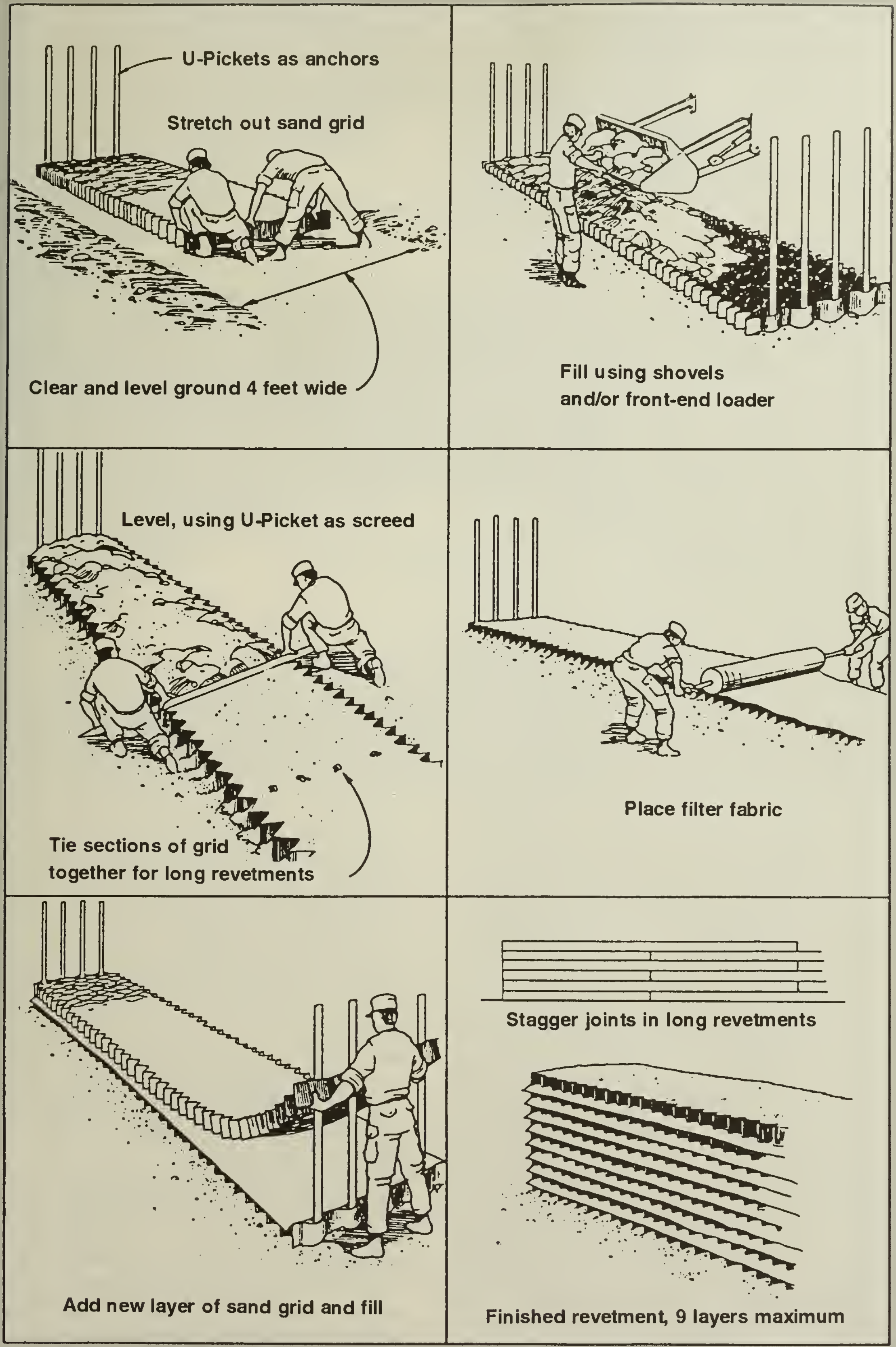
Two types of sand-grid sections are available for constructing field fortifications:

- Standard sections are essentially the same as those used in roadway construction but are narrower.
- Notched sand grid is a standard section that has been modified to allow revetment construction with complete sand and soil confinement on the sides. It eliminates the need for a filter fabric between layers of sand grid and allows multiple layers to be filled. Notched sand grid can be constructed more rapidly than standard sand grid.

Sand-grid sections for field fortifications are manufactured in black, green and tan. Camouflage paint can be added to protect them from ultraviolet degradation and to reduce enemy detection. The sections are used to construct artillery positions, helicopter revetments, overhead protection, blast and fragmentation protection and bunkers. Sand grid is effective against small-arms fire up to .50-caliber and near-miss artillery rounds.

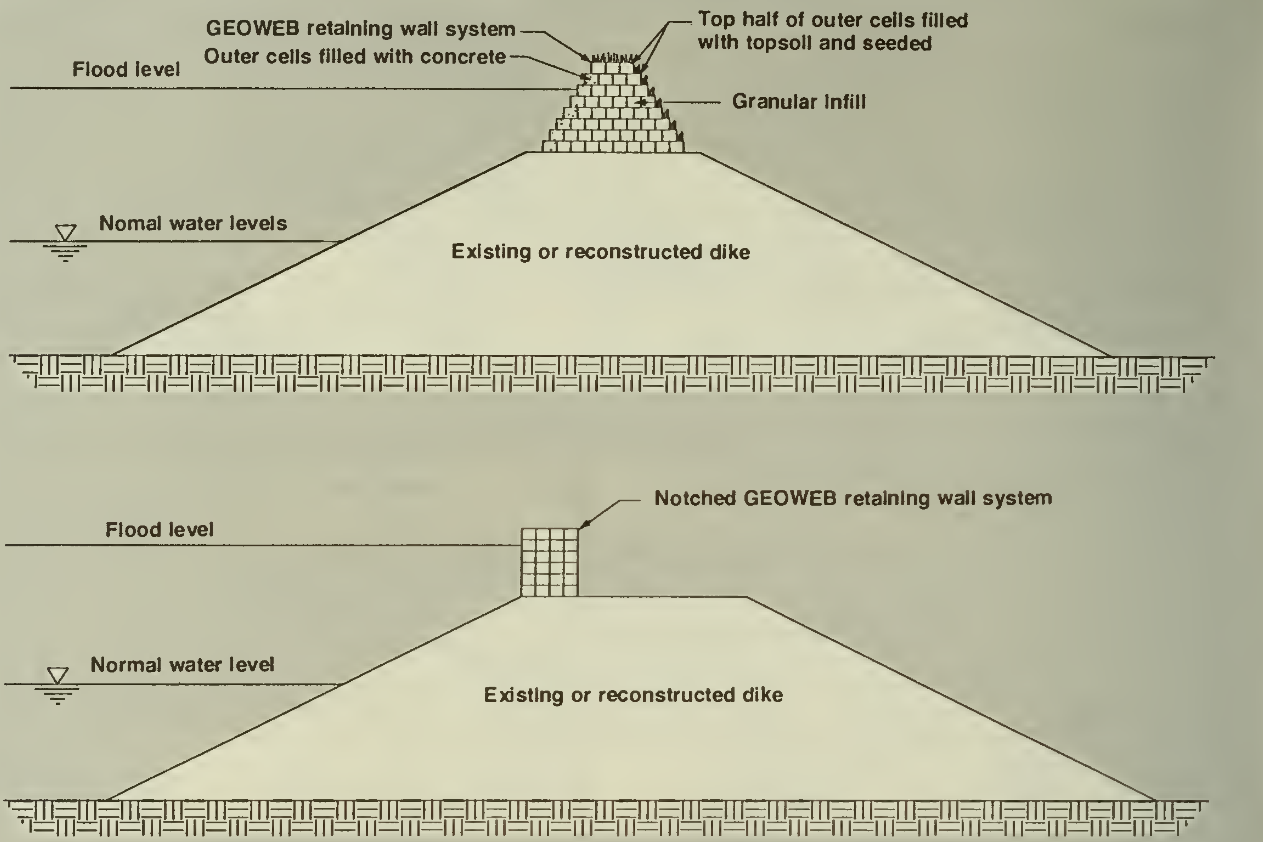
Many advantages can be realized by using sand grid to construct field fortifications. For example, field fortifications made with sand grid—

- Cost 28 percent less than those made with sandbag revetment materials.
- Occupy 50 percent less space than those made with sandbags, although they weigh 15 percent more.


U-Pickets as anchors
Stretch out sand grid
Clear and level ground 4 feet wide
Fill using shovels and/or front-end loader
Level, using U-Picket as screed
Tie sections of grid together for long revetments
Place filter fabric
Add new layer of sand grid and fill
Stagger joints in long revetments
Finished revetment, 9 layers maximum

Artwork from *Expedient Field Fortifications Using Sand-Grid Construction*

Construction of standard sand-grid revetment


GEOWEB retaining wall system
Outer cells filled with concrete
Flood level
Top half of outer cells filled with topsoil and seeded
Granular infill
Nomal water levels
Existing or reconstructed dike
Notched GEOWEB retaining wall system
Flood level
Normal water level
Existing or reconstructed dike

Fortifications of dikes and levees using standard and notched sand grid. These methods replace sandbags and allow rapid construction to increase the height of a structure.

Art courtesy Presto Products Company

- Are more durable than those made with cloth sandbags and have a longer life expectancy. Some revetments made with sand grid are in good condition three years after construction, while sandbag revetments may require repair after only six months.
- Require from 40 to 70 percent fewer man-hours to construct than those made with conventional sandbags.
- Take half the time to construct and yield the same amount of protection as an overhead protective cover system made with standard sandbags and loose earth.

Other Expedient Structures. In addition to the uses already described, sand grid can be used for earth-retaining walls; drainage-channel linings; slope erosion control and stabilization; and river fords, dikes, and levees. Some examples follow.

Sand grid can be used as protection for drainage channels. The St. Louis Metropolitan Sewer District (MSD) decided to use it as an alternative to reinforced concrete and concrete slab channel linings. They chose sand grid because it offered significant cost-savings benefits. By using sand grid, they eliminated the need to construct concrete formwork and the need for reinforcing steel and expansion joints. The sand grid provides a permanent, flexible form and acts as a series of expansion joints when filled with concrete. A cost-saving feature is that no overfill is required over the depth of the cells, which makes it easy to calculate the amount of concrete required. Since 1987, the St. Louis MSD has used sand grid filled with concrete for channel protection. They estimate that sand-grid construction costs about 30 to 40 percent less than traditional concrete construction.

The U.S. Forest Service used sand grid filled with coarse aggregate to construct a 16-foot-wide by 40-foot-long river ford in the Chattahoochee-Oconee National Forest to replace a log stringer bridge. Replacing this bridge before sand grid was available required the construction of an 8-inch-deep by 14-foot-wide mesh-reinforced concrete ford, which cost from $6,000 to $12,000. The ford made with sand grid costs about $3,000.

The great flood of 1993 will be remembered for many years. We all witnessed the destruction that took place as river waters crested and overtopped protective dikes and levees. The flood caused an estimated $20 billion in damages. The U.S. Army Corps of Engineers distributed in excess of 31 million sandbags to hold back flood waters. Most of the dikes and levees were reinforced with sandbags, and filling and placing them was time-consuming and required thousands of people.

It is possible to fortify dikes and levees with sand-grid construction. Using sand grid requires less time and fewer personnel than other methods, and it allows workers to rapidly increase the height of a dike or levee to prevent overtopping. Because of its load-support capabilities, sand grid can be built with heavy construction equipment, which significantly increases the construction rate. When sand grid is used to construct temporary dikes and levees, the structures also function as a temporary dam. WES evaluated a sand-grid system under conditions of varying water levels and wave actions to prove its usefulness. They concluded, "This type of structure, either temporary or permanent, holds promise as an expedient alternative to sandbag structures."

Synopsis

Sand grid is a multipurpose construction system. It is an economical, effective and often overlooked resource that can be adapted to a wide variety of construction applications. Sand grid is available to military engineers and can be easily transported and installed. It requires less time, effort and maintenance than conventional construction materials. For more information on the uses of sand grid, call the Department of Construction Engineering, U.S. Army Engineer School, at (314) 596-0131 (Extension 3-7620/7610) or (Defense Switched Network) 676-7620/7610; or write to Commander, U.S. Army Engineer School, Attention: ATSE-T-CT-H, Fort Leonard Wood, Missouri 65473.

SFC Purinton is an instructor/writer for the Engineer School's Department of Construction Engineering. He previously served as technical engineering supervisor and platoon sergeant, 802nd Engineer Battalion (Combat) (Heavy), and as a senior instructor for the Materials Quality Specialist Course. SFC Purinton is a graduate of the Advanced Noncommissioned Officers Course (ANCOC) and holds an associate's degree in construction management from Park College.

SFC Harrison is an instructor/writer for the Engineer School's Department of Construction Engineering. He previously served as platoon sergeant, 568th Engineer Battalion (Combat) (Heavy), and as a senior instructor for the General Construction Equipment Course. SFC Harrison is a graduate of ANCOC and holds an associate's degree in construction management from Park College.

Additional Reading

Field Circular 5-104-1, *Airfield Damage Repair*, October 1985.

Field Manual (FM) 5-103, *Survivability*, June 1985.

FM 5-410, *Military Soils Engineering*, December 1992.

FM 5-430-00-1, *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations-Road Design*, August 1994.

Training Circular 5-340, *Air Base Damage Repair (Pavement Repair)*, December 1988.

The Presto GEOWEB Cellular Confinement System, Brochure, Presto Products Company, Appleton, Wisconsin, 1992.

Grau, R. H.; Bush, A. J. III; Coleman, D. L.; Godwin, L. N.; and Webster, S. L., *Dust Control in Desert Environments*, Miscellaneous Paper GL-92-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, January 1992.

Green, H. L., and Williams, T. P., *Installation of Air Transportation Airfield Damage Repair Kit*, Instruction Report GL-90-1, U.S. Army Engineer Waterways Experiment Station,Vicksburg, Mississippi, February 1990.

Hayes, P. G., *Expedient Field Fortifications Using Sand-Grid Construction*, Technical Report SL-88-39, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, October 1988.

Martin, S., *Dike and Levee Fortification and Reconstruction Using Presto GEOWEB Cellular Confinement Systems*, Presto Products Company, Appleton, Wisconsin.

Pence, L. M., Jr. *A Plastic Ford, You've Got To Be Kidding*, Engineering Field Notes, U.S. Forest Service, United States Department of Agriculture, Washington, D.C., Volume 19, January-February 1987.

Webster, S. L., *Sand-Grid Demonstration Roads Constructed for JLOTS II Tests at Fort Story, Virginia*, Technical Report GL-86-19, U.S. Army Engineer Waterways Experiment Station,Vicksburg, Mississippi, November 1986.

Harvesting A Partnership:

A Captain's Perspective

By Major Brian Loggins

District assignments with the Corps of Engineers can be both challenging and rewarding for military engineers. My experience at the Fort Knox Area Office in 1992, as a captain, is a case in point. During this assignment, I was introduced to "partnering," which was then a new concept in the Army's commitment to Total Quality Management.

As the lone "green suiter" and the newest guy in the Fort Knox Area Office, I was not surprised to learn that I would be the project engineer for renovation of the Fort Knox commissary. At $1.6 million, the Corps of Engineers considered the renovation a small project; and I assumed a few renovations to a grocery store would be easy. However, examination of the project drawings and specifications showed that the project would be more complex than I initially thought. In fact, it had the potential to be a nightmare. It was a major overhaul that included everything from replacing the lighting, refrigeration equipment, and heating and air-conditioning units to constructing a new manager's office and a breakroom for the grocery baggers. All of this, and more, must be done while the commissary remained open for its nearly 2,000 customers per day—with business as usual!

The district commander suggested that we partner the project. Knowing little about this concept, I did some research and learned that its goal is to bring the key players of a project together as a team, working for the good of the

The contractor coordinated his schedule with the store manager on a weekly basis to minimize inconveniences to shoppers. Here, work progresses while the store is closed.

project and for customers satisfaction, as opposed to working for individual goals. Partnering improves product quality and produces win-win solutions to problems.

This project was well suited to a partnership. It was a complex undertaking that would require difficult decisions and safety considerations. Coordination, teamwork, flexibility, and open communications with everyone involved were essential. A partnership would ensure that these requirements were met.

The contractor immediately said "yes" when asked if he would be interested in partnering the project. That simple agreement set the partnership in motion. The next step was to present a workshop where we would form a team and set project goals.

The Workshop

The workshop, held on 7-8 December 1992, was attended by all of the project's key players: the Corps, the contractor, the commissary manager, the Fort Knox Directorate of Public Works, and the architect-engineer. Attendees included everyone from field representatives to the senior leadership of those organizations. Their participation was critical and demonstrated a high level of commitment to the partnership.

The workshop was professionally facilitated by an "outsider" from New Mexico, whom we hired from a list maintained by the district office. He was worth every cent. Having an impartial, skilled facilitator ensured that everyone had an equal voice. The team-building exercises helped us relax, generated open communications, and kept the group focused on setting goals and having fun. At this point, everyone was totally committed to the project.

After we became a team, we developed goals and objectives. To maintain open communications, we decided to meet weekly to share progress reports and monthly to discuss and assess the partnership.

We also chose a partnership logo and motto. The cornucopia and the motto, "Harvesting Partnership" seemed most fitting for a commissary project. To announce the partnership, the contractor added a brightly colored sign depicting the logo to a sign in front of the commissary.

The team approach to problem solving proved successful, especially during complicated and hazardous operations such as lifting air conditioning units onto the roof.

The Partnership

After the workshop, the project picked up momentum.

LOUISVILLE DISTRICT
ENGINEER

Harvesting Partnership

DIRECTORATE OF ENGINEERING AND HOUSING

PARTNERING AGREEMENT
FOR
THE CONSTRUCTION MANAGEMENT TEAM
FOR THE FORT KNOX COMMISSARY RENOVATION
FORT KNOX, KY

Mission Statement

We will work together in an open, cooperative and professional manner to provide a safe, high quality Fort Knox Commissary renovation, with minimal disruption to the customer.

Goals and Objectives

Cooperative Relationship

- Open communication
- Team approach to decision making/problem solving * monthly (Field) * 5 May 93 (All)
- Flexibility among all partners
- Focus on project - not personalities
- No formal disputes
- Minimize written correspondence
- Have lots of FUN!

Customer Satisfaction

- Minimize "store" inconvenience
- Provide accessible equipment
- Provide maintainable equipment
- Provide prompt response for critical equipment service
- Meet equipment installation schedule
- Minimize and coordinate utility interruptions
- Establish acceptable job sequence

On Schedule

- Mutually agreed master schedule
  - Address schedule weekly with two week look ahead
  - Achieve mutually established milestones
- Timely resolution
  - Two day maximum (on site)
  - One week maximum (field)
  - Thirty days for change orders requiring more funds
- Jointly established priorities
  - Team concurrence at weekly meetings
  - Flexibility to accommodate each others priorities

Quality

- Build without rework (assumes effective QA/QC)
- Meet or exceed requirements (K Specs)
- Meet or exceed customer expectations
- Identify and discuss key submittals before submitting to achieve correct submittals on a first time basis
- Develop and maintain DECA as an equal partner

Safety

- No lost-time accidents
- No public/customer accidents
- Conduct thorough Activity Hazard Analysis (AHA)
- Conduct thorough safety indoctrination and weekly toolbox meetings - Discuss AHA daily
- Comply with Accident Prevention Plan

Within Budget

- Fair profit to Contractor (including Sub-contractors)
- Contain total cost growth to within 5%
- Proactively pursue savings through V/E process

Gary L. [illegible]
Dennis R. Kelly
John Trinkle
Joe M. Kitt
J. Darrell Nation
Michael A. [illegible]
Robert W. [illegible]
Robert E. [illegible]
Gary [illegible]
Jack [illegible]
George D. Henry
David H. Wills
David A. [illegible]
David K. [illegible]
Lewis H. Graham
Dennis J. [illegible]
James R. Linder

RMI
RELIABLE MECHANICAL INC.

A-BELL ELECTRIC CO. INC.
ELECTRICAL CONTRACTORS

ZBA

USA ARMOR CENTER

We brainstormed and solved all issues and potential change orders as a team. And, because the contractor was involved in the problem solving, his price proposals for changes were usually very reasonable.

At first everything went well. Then, within a few days, we experienced two on-the-job safety problems. The contractor agreed with us that while neither incident was very serious, a pattern seemed to be developing. He and his staff immediately took corrective action and briefed all of their employees. The next day he informed us that one individual had been fired and a foreman replaced. While this initially seemed extreme, I was impressed with the contractor's commitment to safety and to the partnership. His action was effective—no more safety problems occurred.

At the weekly progress meetings, the project manager for the prime contractor briefed the schedule for the next two weeks, and the subcontractors briefed the status of their work. This kept everyone informed and prevented unwanted surprises. All issues raised were discussed openly among team members. The commissary manager was especially pleased with the progress and the quality of work performed.

Each month we met to discuss and assess the partnership. These meetings allowed the field representatives to evaluate how the partnership was working. There were rarely any negative comments.

As the work progressed, a high level of trust and confidence developed among the partners. Of the many examples of cooperation, professionalism, and teamwork that occurred, two were especially significant:

- While the contractor was replacing the front door to the commissary, a temporary entrance was made for customers. As Memorial Day weekend approached, the commissary manager realized that the temporary entrance would be inadequate for the large crowd expected. When alerted to the problem, the contractor voluntarily modified his schedule and installed the new door in time for the weekend.
- When the contractor needed to remove an old refrigerated case ahead of schedule and on very short notice, the commissary manager came to his aid. He quickly gathered some of his employees from their scheduled tasks to empty produce from the case.

These examples illustrate the partners' commitment to the project and to customer satisfaction, and they underscore the value of the partnering concept.

Assessment

Partnering is similar to what we experience daily as soldiers. We are all members of a team, whether it's a battalion staff, a squad, or "this" project team. During the renovation project, I learned the importance of developing trust and team spirit among team members. If team spirit is not developed, team members may concentrate on their hidden agendas instead of on team goals. The power of a team, when individual skills and resources are combined, is enormous.

At Fort Knox, forming a partnership was the key to the success of this project. And now, because we harvested a partnership, the commissary and its customers are reaping the benefits.

Major Brian Loggins is director of quality for the Louisville District, Corps of Engineers. He formerly served as chief of quality assurance at the Fort Knox Area Office. Major Loggins is a graduate of Vanderbilt University.

(Personal Viewpoint, continued)

soldiers must be trained in *tool maintenance!* The plan must outline priorities and procedures for obtaining repair parts. Leaders must listen! Soldiers know what is needed to perform maintenance. Encourage suggestions, innovations, and time-saving techniques.

Doctrine

Maintenance plans must embrace every asset, every resource, every bit of expertise, and every communication channel to which the unit can gain access. Channels include logistic assistance offices (LAOs); IDEAS, TIPS, and SMART programs; contemporary maintenance publications (*PS Magazine*); standing operating procedures from other units; the exchange of ideas and policies throughout the command; project manager and item manager offices; and civilian manufacturing publications. The list is endless and is limited only by imagination and drive. Once in place, those channels must be maintained if they are to be worthwhile.

My challenge to you is this: How good is your maintenance operation? Has the commander identified the organization's values? Is your maintenance plan realistic, goal oriented, value reinforcing, well coordinated, and fully supported? Does each team member have a vital part to play in executing the plan? Is each maintenance session conducted as leader-supervised team training? Will your maintenance operation be a triumphant march or a swan song?

SFC Moeller is a Force Integrator/Force Readiness NCO with the Directorate of Combat Developments, U.S. Army Engineer School. He will retire from the Army with more than 20 years of service as an engineer equipment repairer in January 1995.

HEAVY DIVISION ENGINEER COMMANDER'S HANDBOOK

"A combat engineer company, structured to operate at the FEBA, focuses on mobility, countermobility, and survivability operations. It is the lowest engineer echelon that can plan and execute 24-hour operations in support of maneuver forces."
Field Manual 71-123

By Captain David Brinkley

Your heavy division engineer company has realigned into a new force structure, but there is no doctrine to help you, the engineer company commander, understand the employment, capabilities, and limitations of the company in its new structure. FM 5-71-100 describes the division's combat engineer brigade but is not very useful at task force level and below. FMs 71-2 and 71-123 still refer to pre-restructured engineer organizations and capabilities. Here is the good news—help is on the way! The U.S. Army Engineer School is producing doctrinal manuals for the divisional engineer battalion and company that are scheduled to be released as coordinating drafts in FY 95. The following information provides some interim guidance to alleviate misconceptions and to serve as an employment guide until the doctrine is published. The information, work rates, and capabilities highlighted are based on an 18-month study completed at the National Training Center (NTC) from March 1992 through August 1993. Restructured divisional and corps combat engineer companies that supported 18 mechanized infantry task forces were included in the study.

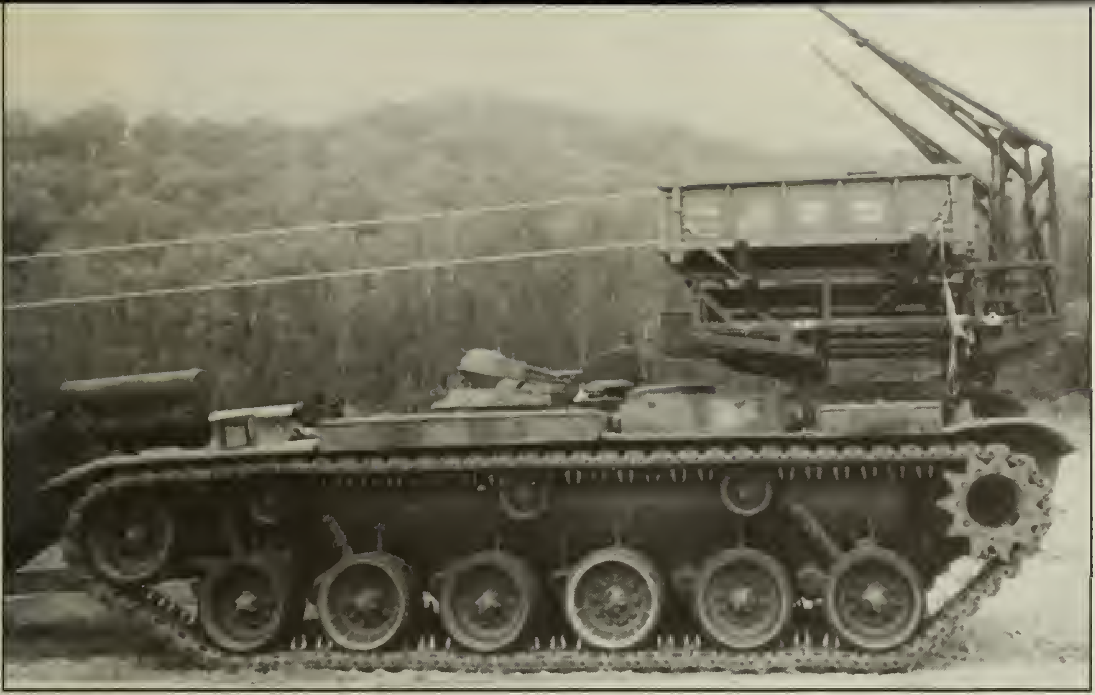
Under the new structure, the major missions for divisional engineers—mobility, countermobility, and survivability (M/CM/S)—have not changed. However, to effectively support the task force, commanders must understand their roles and responsibilities under the engineer restructure concept. (For more information about the restructure concept, see two articles in the August 1994 issue of *ENGINEER*, beginning on page 40.)

Command and Control

The engineer company normally provides the task force with a planning cell that consists of the engineer company command post and is capable of 24-hour operations. This mobile planning cell usually operates out of an armored personnel carrier (APC) or a HMMWV. It is generally led by the engineer company executive officer (XO), who acts as the task force engineer plans officer and provides the task force with an experienced engineer leader in the tactical operations center (TOC). The cell includes the company operations sergeant, the driver, and the NBC and communications sergeants as shift NCOs.

Engineer Cell Functions

- ☐ Prepare a detailed terrain analysis of the task force area of operations. The XO works with the task force S2 section to develop this analysis.
- ☐ Evaluate the enemy's M/CM/S capabilities for integration into the task force situation template.
- ☐ Recommend M/CM/S capabilities for use during the task force tactical decision-making process.
- ☐ Track engineer operations within the task force area of operations and participate in the task force planning process.



This prototype AVLM was designed by the Directorate of Combat Developments at the Engineer School. The prototype is currently undergoing testing and evaluation by the Army Materiel Command. Type classification of the design is anticipated by October 1996.

Mobility

The modern, heavy task force, with its associated engineer company, has twelve times the mobility capability of the heavy task force a decade ago. Although this represents a quantum improvement in capability, it has created an equally large challenge in planning and correct usage. The engineer planning cell must estimate how many breaches the task force can perform, based on the depth and width of each lane and the proposed breaching technique. For example, assuming that lanes are to be 4 meters by 100 meters (this constitutes a one-way, vehicular lane), a balanced task force with all organic and attached assets should be able to breach—

- Two dismounted lanes or one lane per engineer platoon.
- Six lanes with tank plows or one lane per operational tank plow combination.
- Four lanes with line charges or one lane per MICLIC.
- Four 17-meter gaps or one gap per operational AVLB.

A unit's lane-making capability is constrained by several factors. A major factor is the operational readiness of the breaching systems, which are often combinations of a vehicle and a breaching system. For example, a unit's M1A1 tank may be operational, but its attached mine plow may be inoperable. Or the MICLIC may be operational, but its conveyance system may be inoperable. In both cases, maintenance problems degrade the lane-making capability of the task force.

The density, design, and location of enemy minefields and other obstacles are also important when calculating lane-making capability. For example, the presence of a 200- by 800-meter, artillery-delivered FASCAM minefield will effectively double the breaching equipment required to create a lane. Similarly, the presence of antitank ditches, which require specialized equipment to breach, will affect the number of lanes a task force can create.

Terrain is another factor that affects breaching capability. For example, the task force can create lanes in rough terrain with dismounted engineers; in rocky terrain with explosive line charges; and in smooth, cleared soil conditions with tank plows. The engineer planning cell should recommend a breaching technique based on terrain and the types

Mobility Planning Checklist

☐ Determine the breaching capacity of the task force based on standard 4- by 100-meter lanes.

☐ Constrain the breaching capacity by 4 meters through the expected enemy minefield depth.

☐ Determine which of these breaching assets are available:
- Tanks and plows
- MICLIC and carrier
- AVLB and carrier
- Engineer squad carriers and squads
- CEV and M9 ACE

☐ Choose the breaching method based on terrain conditions.

☐ Determine the amount of marking material required to mark potential lanes.

☐ Constrain for 50- to 100-percent redundancy.

Obstacle Construction Capability Per Engineer Company		
Obstacle	***Capability***	***Remarks***
Hand-emplaced minefield	200 meters per hour	100 meters per hour per platoon
Antitank ditch	50 meters per hour	A two-ACE team is required to construct one antitank ditch
Volcano	555 meters per 15 minutes	Construction time for a blocking obstacle
GEMSS minefield	500 meters per 15 minutes	
Artillery-delivered minefield	1 or 2	Engineers plan location

Table 1

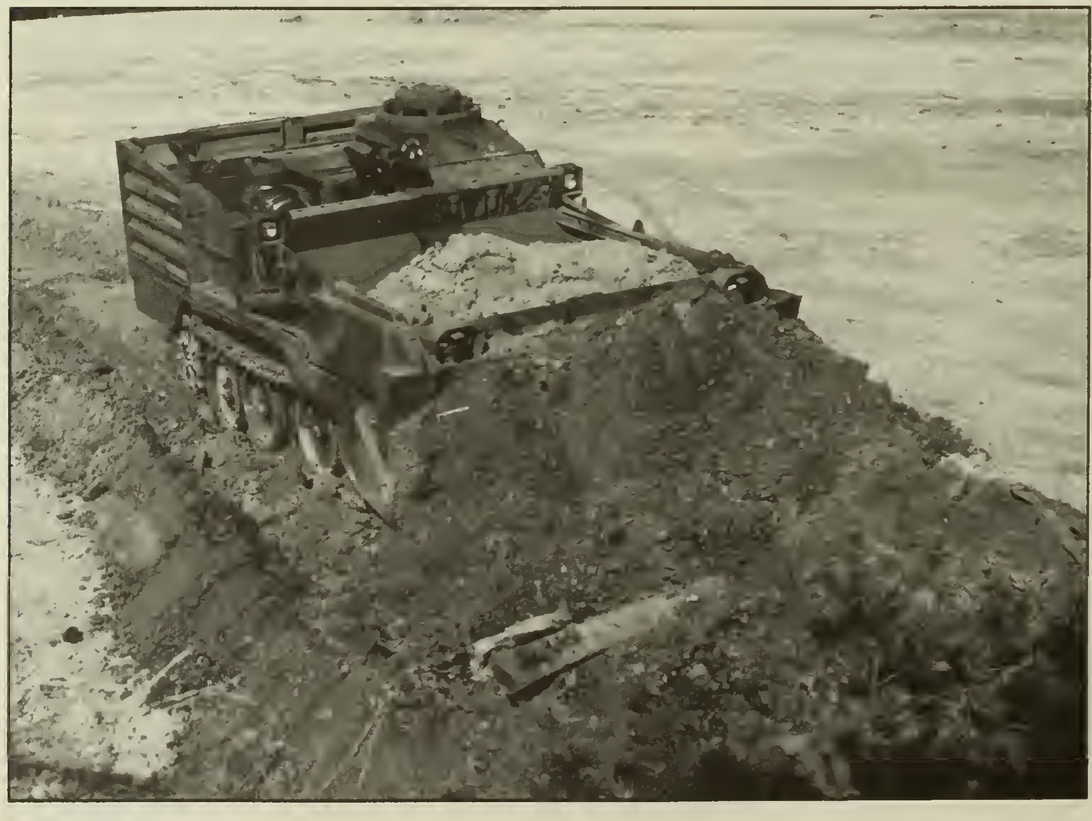
of obstacles to be breached. The Engineer School recommends that a task force have 50- to 100-percent redundancy of breaching assets for any breaching operation. This limitation constrains the number of lanes a task force can effectively create.

The task force is capable of crossing gaps with its AVLBs, CEVs, or M9 ACEs (ACEs). It can bridge four 17-meter gaps. The CEV or ACE can fill small gaps such as antitank ditches and road craters. Most units in the NTC study converted one or two AVLB carriers into armored vehicle-launched MICLIC (AVLM) vehicles and used them to carry the MICLIC. This conversion should be a METT-T decision based on an analysis of the potential gaps to be crossed. (Note: Currently, DA has issued a safety-use message restricting use of AVLMs pending approval of a standardized design. A design submitted by the Engineer School is now under study by the Army Materiel Command (see photo, page 45.)

Countermobility

Unlike mobility, most of the countermobility effort available to the task force comes from the engineer company. Because it now has one less platoon, the new engineer company may appear to have less countermobility capability than it had prior to restructuring. However, the new mine and mine-dispensing systems enable the engineer company to exceed their previous countermobility capability. Table 1 shows the capabilities of the engineer company to create obstacles and planning factors for obstacle construction.

The engineer planning cell must provide the task force S3 with an estimate of the number and types of tactical obstacles that the engineer company can provide to support the direct-fire weapon systems. The initial estimate should be simple and definable



The M9 ACE was designed to be the primary earthmover for the heavy division engineer company. However, many combat engineer companies will have the D7 bulldozer in lieu of the ACE.

The dismounted combat engineer continues to bring versatility to the battlefield through his adaptability and flexibility. This is particularly important given today's complex engineer mission requirements.

and state the number of obstacles that can be constructed. It should include an NLT start time and an estimate of materials required.

Obstacles should be designed according to FM 20-32 and should be described as *turning, fixing, blocking, or disrupting* to avoid confusion in obstacle placement or design. Most engineer companies in the NTC study group used the fixing obstacle as their "base" obstacle when developing an estimate of obstacle capability. During the war-gaming session, the staff will use the obstacle estimate to develop obstacle groups and the obstacle overlay.

The number of obstacles a company creates is a function of their construction rate, constrained by obstacle design and time lost to travel, preparation, equipment maintenance, crew rest, and resupply. The training level of the engineer unit significantly impacts their ability to produce obstacles and construct fortifications. Also, the time spent constructing antitank ditches reduces the amount of time available to construct fighting positions. The average engineer company in the study group emplaced approximately 200 meters of obstacle frontage per hour and 50 meters of antitank ditch per hour. For planning purposes, the Engineer School recommends a planning factor of 10 hours for obstacle construction. This figure is constrained for the obstacles listed in Table 1. The remaining 14 hours a day are used for movement, mine-dump preparation, maintenance, and resupply and refitting.

Engagement area planning must be completed before effective countermobility work can begin. Without a plan, the task force will not realize any enhanced combat potential from the obstacle emplacement effort. Nevertheless, the length of time required for the maneuver company/teams to develop a direct-fire plan and to build the engagement area results in more engineer work delays than any other factor. Engineers can start work before the engagement area has been completed, but they cannot always do so productively until the direct-fire plan is developed and the weapon systems are sited.

Countermobility Planning Checklist

- ☐ Determine how many obstacles are potentially available.
- ☐ Determine when the engineers can begin work.
- ☐ Determine when the task force will be ready for the engineers to begin work.
- ☐ Ask when the maneuver company/teams will have their respective engagement areas sufficiently developed to incorporate countermobility efforts.
- ☐ Determine the amount of Class IV and Class V materials available for preparation of the defense.
- ☐ Ask if the task force maneuver company/teams will emplace obstacles and where this additional effort will be used.
- ☐ Determine obstacle restrictions.

Survivability

The engineer company is equipped to construct vehicle and crew-served positions for the task force. The planning cell normally provides the task force S3 with an estimated number of positions that can be dug, based on engineer equipment and time available. The estimated number is constrained

Work Rates and Planning Factors

(Assume all equipment is available)

Equipment	*Number of Two-Tiered Fighting Positions*			
	24 Hours	*36 Hours*	*48 Hours*	*60 Hours*
2 Dozers	12	18	24	32
7 M9 ACEs	12	19	25	32
3 SEEs*	30	45	60	75

* Crew-served weapons positions

Table 2

by movement requirements, construction rates, equipment availability, operator proficiency, and soil or terrain conditions. The planning cell should recommend where positions can be built for maximum advantage and where positions are not feasible because of soil conditions. Ultimately, the number of positions that can be built is determined by the direct-fire plan. Unless the direct-fire systems are properly sited, position construction for these elements may be wasted or misdirected effort.

The task force generally takes several hours to plan the defensive battle, reconnoiter the engagement area, and develop direct-fire plans at the maneuver company/team level. The NTC study showed that engineer equipment is usually stationary and unemployed during that time. However, commanders must maximize engineer equipment time without wasting the unit's effort. Air defense artillery, mortars, TOC, and combat train areas often receive no survivability effort because work priority is allocated to direct-fire systems.

One alternative is for engineer units to fortify the indirect, air defense, and combat support systems during that time. These positions require less precise ground positioning and are less time-consuming to construct than direct-fire positions. This engineer effort will increase the overall survivability of the force without degrading the direct-fire system fortifications.

Doctrinally, an engineer company can prepare 12 two-tiered fighting positions and 30 crew-served weapons positions in a 24-hour period. For planning, the Engineer School recommends a factor of 15 hours per blade team per day for fighting position construction. The remining 9 hours are used for maintenance, repair, refueling and travel. Table 2 shows work rates and planning factors for the engineer company to construct two-tiered fighting positions.

Survivability Planning Checklist

- ☐ Determine how many positions can be built.
- ☐ Determine which type of position is recommended.
- ☐ Determine if there are any digging restrictions.
- ☐ Ask when the equipment will be available.
- ☐ Ask when the maneuver company/teams will be ready to start position construction.

Limitations

The NTC study compiled data for 18 force-on-force operations and identified several limitations. The following limitations have since been mirrored in operations at other combat training centers:

Logistics. The most significant limitation facing the engineer company is its austere logistical organization. The company has no organic maintenance, Class IX material, recovery, or medical evacuation capabilities. These assets are consolidated with the engineer battalion. This is a significant change from the previous engineer organization.

Communications. The engineer company may experience extended lines of communication with the engineer battalion. Engineer battalion trains are normally found in the brigade support area. Generally, when the engineer company is working well forward, the task force combat trains are between the engineer company and the engineer battalion trains. All engineer companies in the NTC study ultimately became attached to their respective task forces because of extended distances to the engineer battalion trains.

Maintenance. The engineer battalion is authorized three maintenance support teams (MSTs) in the headquarters maintenance section. An attached engineer company should come with an MST from the engineer battalion, but there are only three MSTs to support three engineer companies and the HHC. This places a burden on the task force because most engineer-specific equipment is low-density, high-maintenance, and specialized. The task force does not normally maintain the PLL required for equipment in the engineer company, nor does it have the expertise or the experience to properly repair this equipment. Also, engineer battalions generally have a consolidated

PLL, which makes it difficult to prepare Class IX packages for each attached engineer company. The engineer battalion should receive an MST from the forward support battalion to facilitate speedy battlefield repair. Future battalion organizations will have modular CSS functions that will better support separate company operations.

Recovery Assets. The engineer battalion maintenance section does not provide for recovery assets within each company. The two recovery vehicles (M88s) allocated to the engineer battalion must support the entire engineer battalion across the maneuver brigade sector. The engineer commander must plan for self-recovery during combat. Frequently, companies in the study group used AVLBs for adhoc recovery.

Special Tools. The engineer company has several specialized pieces of equipment. The M9 ACE, SEE, M728 CEV, and M48A5/60 AVLB all require special maintenance skills and special tools. The engineer battalion MTOE authorizes only a single special tool for some equipment, such as SEE and ACE special tool sets. Because these sets must be shared by three companies, the engineers are severely limited in their ability to fix forward or quickly repair the specialized equipment. This issue may be alleviated when the battalion support platoon is redesigned (currently under way) to support modular, separate operations.

Medics. The engineer company generally receives two medics from the HHC. Because no ambulances are authorized for the engineer battalion, the company must use organic, soft-skinned, or combat vehicles to evacuate the wounded. This additional burden on the task force medical platoon limits their ability to support the engineer company on an area basis. The commander must understand the medical support plan in order to evacuate engineers quickly and efficiently.

Operational Readiness. Data compiled during the NTC study showed that, when in direct or general support (DS or GS), engineer companies waited extended periods of time to receive repair parts, supplies, and Classes IV, V, and IX material during their NTC rotations. Many of the DS companies in the study group suffered operational readiness rates ranging between 20 and 50 percent after five days of combat operations, without any combat losses. Combat Maneuver Training Center Hohenfels reports similar trends. In the NTC study, readiness rates were directly related to operator training and leader involvement in operator supervision, especially for low-density engineer equipment like the ACE.

Equipment Recovery. Companies that are DS or GS must recover damaged or repairable equipment past the task force UMCP and field trains to the engineer battalion UMCP in the brigade rear. These distances may be extensive and overburden an already austere organization. Until changes to the organization are approved, the engineer company must plan for self-recovery to a maintenance collection point.

Command and Control. Command and control (C2) are also potential shortcomings for the engineer company. Most engineer companies lack a dedicated C2 vehicle for the company command post. The company XO and commander share an M998 and an M113A2, and the mission dictates which vehicle supports the engineer planning cell. Because neither is adequately configured to be a command post vehicle, the engineers are limited in their ability to effectively integrate into the task force TOC. The M577 is the preferred vehicle for the engineer command post and should be included in future force structure changes. Until then, integrated engineer command post and task force TOC operations will be limited.

Looking Forward

The new divisional engineer organization provides a modernized task force with superior breaching capability, better engineer C2, and increased survivability and countermobility potential. These improvements greatly enhance the mobility of the force and its ability to defend and survive on the modern battlefield. The increased capability has been accomplished with a smaller, better-equipped force structure that has some limitations, mostly in the logistical arena. Even better force mobility and protection will be provided as the Volcano and wide-area mine (WAM) systems, M1-based breacher and bridger, and improved engineer squad carriers are fielded. As the engineer company structure changes, doctrine will evolve to support that change. In the meantime, the guidance in this article should fill the void in doctrine and assist you and your company as it supports the maneuver force. The engineers now have a force structure that can fully and adequately support the heavy task force any place and any time.

Captain Brinkley is the primary author of FM 5-71-2, Task Force Engineer and Engineer Company (Armored). Previous assignments include observer/controller at the NTC; company commander and battalion S3 with the 78th Engineer Battalion (Germany); and Brigade Engineer, S4, and platoon leader with the 1st Engineer Battalion, Fort Riley. He is a graduate of the Command and General Staff Officer's Course and CAS3. CPT Brinkley has a bachelor of engineering degree from Virginia Tech.

Auftragstaktik:

Mission-Based Leadership

Brigadier General Karl Hoffman, German Army Corps of Engineers, spoke to U.S. Army Engineer School staff in October 1994, concerning his views on independent mission analysis and military leadership.

Today I will speak about *auftragstaktik*, which means mission-type orders. I will try to explain what the word implies and whether this important leadership concept can be revitalized.

Command and control of mobile formations on the modern battlefield is a challenge. For decades, all forces have been looking for command and control procedures that are appropriate for this challenge. In the 1970s, Colonel T. N. Dupuy, a leading American military historian, made a survey of Prussian-German command and control procedures used during the 19th and the 20th centuries. Dupuy found that from 1807 to 1945, Prussian-German armies had been consistently superior to their opponents in terms of quality, command and control procedures. The results of Dupuy's research were supported by a follow-up study conducted by Martin van Creveld, a Hebrew military historian. Accordingly, experts, first from the U.S.A., soon demanded that German procedures (called auftragstaktik) be adopted.

One point is evident: If it is true to say that the German combat effectiveness was superior, we must examine the reason why. It was certainly not a higher degree of braveness that led to this superiority. Many nations have put forces of admirable braveness on the battlefield. And there is nothing like an innate German superiority in combat effectiveness. Numerous wars have shown how quickly the quality of a nation's military forces can change. For example, in the middle of the 18th century, Prussians and Hanoveranians defeated French forces without much effort, even when the latter were clearly superior. In 1806/07 the French defeated the Prussians whenever they met. In 1813/15 it was again the Prussians who defeated the French, except when Napoleon held the French command.

Apparently, units from all nations fight bravely if some basic requirements are met: a convincing reason to wage war; an internal bond, keeping the soldiers together; the presence of officers and NCOs the soldiers trust; and a sufficient supply of arms.

Roots of Combat Effectiveness

Those are reasons why soldiers fight. But it is not enough to have soldiers fight effectively. In many cases, a high degree of combat effectiveness may be the result of superior tactics. But tactics are not the only root of a high degree of combat effectiveness. This is shown by the battle for Crete, in 1941.

In that battle, the Germans had air superiority. But the British-Greek defenders had more and much better trumps to play. They ruled the ocean. They were overwhelmingly superior by numbers. They held prepared positions. At that time, paratroopers and airborne troops could carry little more than their handguns; their first assault echelons had only a few light mortars and a few radio sets, at best. Only after an airfield had been seized was it possible to send in light cannons. It was impossible for the Germans to supply tanks, armored infantry fighting vehicles or trucks, although those vehicles were available to the defending units. Even worse, the defending units knew the German radio code. So they were familiar with every detail of the German plan of attack, including the time of attack and landing zones.

Using parachutes and gliders, the attacking German units landed literally within the positions of vastly superior defending forces, who knew exactly when and where the Germans would attack. Nevertheless, the attacking forces were successful. They seized an island of strategic

East end of Remagen railroad bridge which collapsed 17 March 1945, spilling several hundred engineers into the Rhine River at Remagen, Germany. By waiting for orders to seize the bridge, the U.S. lost the initiative. German forces were able to reinforce their troops and finally destroy the bridge. While the U.S. ultimately succeeded, immediate action according to the Auftragstaktik principle might at least have saved many lives.

importance and caused casualties in the enemy lines that exceeded the number of their casualties many times over.

It was not superior tactics that brought about the victory. Under the described conditions, German tactics were soon reduced to a desperate struggle for survival, performed by small, isolated units. The attacking forces never had a chance to perform a planned combined arms battle or tactically employ their units and formations.

So, there existed another significant factor besides tactics. This factor was so strong that it offset the terrible disadvantages with which the German paratroopers and mountain troopers had to struggle. In searching for this factor, we turn to Field Marshal Lord Carver, the former British Inspector General. During the Second World War, he participated in many German-British combats as a front-line soldier in Africa, Italy, northern France and Germany. In his book *Dilemmas of the Desert*, Lord Carver wrote that time and again British units were defeated because they failed to move; instead, their unit leaders waited for orders or for approval of their intentions. This implies that forces will fight effectively if the soldiers' braveness is supplemented by two factors: good tactics and initiative (enterprise)—or the willingness of officers, NCOs and enlisted men to act independently and, if need be, even contrary to their obsolete mission.

The importance of acting independently results immediately from the characteristics of war. War is the domain of uncertainty, friction and, often, sheer chaos. It will remain so because war is not waged by machinery but by soldiers operating machinery. So, war is a fight between opposing forces of will and mind. Soldiers' reactions in the face of danger and death, however, are unpredictable. Managerial planning and careful realization of detailed plans may not show soldiers the way through uncertain situations, frictions and chaos.

When the unexpected occurs, those waiting for new orders will lose. But those who react faster than their opponents will win. They will act like a chess player who moves two pieces at a time while his opponent moves only one. If history is not misleading, auftragstaktik is one way to call forth this quick and independent action.

History

Unfortunately, few books or articles provide information on the history and origin of auftragstaktik. Yet this concept is an important and sententious phenomenon. Those who have developed auftragstaktik and have applied this system for the first time appear to have considered it something ordinary, which did not require any special explanation, theory or terminology. Even the term is quite new: It was used commonly only after the Second World War, when what it defined no longer existed.

Anglo-Americans use the term "mission-type orders" for auftragstaktik. This implies that the essence of auftragstaktik is to give the subordinate commander a general mission, while leaving him much liberty in terms of executing the mission. If you adhere to this interpretation and then compare Allied and German combat orders written during the war, you will find surprisingly few differences and not find anything to explain differences in the forces' combat effectiveness. Commanders who commanded their troops from the front lines did this not to have a better view, but to have the ability to intervene quickly and immediately with subordinate formations in executing the mission. Changing only the wording of operation orders will, therefore, not make it possible to revitalize or adopt auftragstaktik.

Contemporaries Evaluate Auftragstaktik

In the mid-19th century, Prussia already looked back on a long tradition of unusual devotion to the profession and duty. The tradition of respect for the subordinate's dignity, which was uncommon at that time, was just as long. That tradition was the basis for the natural development of auftragstaktik. The command and control procedures were not created at that time, nor were they conscientiously developed from a philosophy or by necessity. Instead, they evolved by themselves and were considered normal and natural. This conclusion is evident in documents written by authors from four nations:

- Prince Friedrich Karl, field marshal not only by rank, but soldier and military leader, wrote: "All in all, the Prussian officer corps, unlike any other forces, seem...to have developed an unusual longing for independence from superiors and a willingness to assume responsibility...This attitude also had an undisputable impact on our battle tactics. Prussian officers do not tolerate any restrictions by regulations and schemes, as is the case in Russia, Austria, the United Kingdom ... We give ... free rein to the ingenuity of the individual soldier, perform our arts more easily and support any successful action independently, even when this may be contrary to the intentions of a military leader."
- Thirty years later, an Englishman made the following judgement in what he explicitly called a "critical study" of imperial Germany: "Nowhere in the world, independent thinking and liberty of action is fostered and promoted as much as in the German forces, from the commanding general down to the last NCO."
- A Russian general, who had acted as an observer during the entire German-French war in 1870/1871, concludes his two-volume report as follows: "Actually, the eventual success of the Germans was obtained due to an incredible extent of independent enterprise by the lower-ranking leaders on all levels down to the lowest one, which was displayed on the battlefield and outside of it."
- Shortly after the German-French war, an officer presented a speech at the Ecole Superieur de Guerre—without exception, all course participants had fought in this war. He said: "A common characteristic of all German officers was the firm determination to keep the initiative by all means ... while the soldiers were incited to devote themselves completely and to act autonomously, and while all soldiers were obliged to think, to check and to create their own conceptions ... The NCOs were the backbone of the Prussian forces ... a precious support of the officers. Their special responsibilities, backed by a respect which was unknown in other armies, guaranteed them to hold an honorable and envied position. The Prussian forces were proud of them."

"When the unexpected occurs, those waiting for new orders will lose. But those who react faster . . . will win."

These writings indicate that the command and control procedures of auftragstaktik had not been grafted on an optional basis. Rather, auftragstaktik was founded on many decades of national education, respect of the person, and the dignity of lower-ranking officers, NCOs and enlisted. Last but not least, auftragstaktik was the result of constant observation and promotion of professional skills over decades, which resulted in self-assuredness and self-confidence.

One facet was very important, even crucial: Foreign observers recognized that the high degree of independence was not restricted to the battlefield. They noted that it existed "on the battlefield and outside of it." They perceived independence and self-confidence not only among officers but also among NCOs and enlisted.

These observations show to what extent liberty of action (i.e., execution of a mission by its *sense* not by its *wording*) was part of a general style of living. That style of living is not promoted or revitalized by merely changing the wording in item 3b and following the Operational Command STANAG 2024, describing the execution of the mission (or any order).

Prussian Command and Control Procedures

At first glance, the Prussian command and control procedures may appear to be the same as the procedures of other forces: The officer assessed the situation, made a decision, developed an operation plan and, based on that plan, set up the missions for subordinate units. The subordinate was given his commander's intent and orders, assessed the situation, made a decision, and so on—down to the level of the squad leader. These procedures were the same in all armies; but in the Prussian-German forces, the emphasis seems to have been shifted: The mission embraced in the statement of the commander's intent had higher priority than any detail of the execution process.

This fact may seem to be insignificant but it is not. For, if an unexpected situation developed, it was easier for German commanders to question the validity of the then-obsolete mission and act independently instead—as long as they followed the intention of their next superior.

Thus, if there is a characteristic feature, essence or substance of auftragstaktik, it is not a definite extent (listing) of details or how to execute the mission. The characteristic feature is the clear emphasis on the *intention* of the next superior—and a corresponding reduction in the importance of the mission received. When Field Marshal Prince Friedrich Karl reproved a major, in about 1860, the latter justified his action by replying that he had executed a strict order. Then the Prince rebuked him: "The King has turned you into a major because he thought you knew when not to obey an order." Such anecdotes (this one seems to be true, by the way) belong to the standard repertoire of some forces.

Remarkably, this story was referred to many times, even in semi-official publications of the Prussian forces. So it is no surprise that a military leadership regulation in 1906 included a passage which obliged officers to verify that the mission received was still appropriate in view of the situation and the intention of the next superior.

Revitalization of Auftragstaktik

Whatever was left of auftragstaktik vanished after the breakdown of Germany in 1945. Many years later, interest in auftragstaktik rose again. Perhaps it arose because NATO member nations were looking for a way to balance the high Warsaw Pact superiority in terms of quantity by establishing higher quality in terms of command, control and leadership. Or perhaps there was another reason: A future conflict between high-technology forces may be dominated as much by electronic warfare as forces in the Second World War were dominated by armored vehicles. In the future, military commanders will face quickly changing situations (i.e., obsolete missions). They will be unable to turn to superiors because radio connections will be jammed. Initiative and independent action will, therefore, be even more important in a future war than they were in former conflicts.

This brings about much more than just the question of how operational orders are worded. Wording is important. Yet, another issue needs to be addressed: Are the officers, NCOs and enlisted soldiers in the armed forces capable of implementing auftragstaktik?

What does that mean? It means that the military needs soldiers from all ranks who, upon facing an unexpected situation, start to think automatically: "When my superior gave me this mission he (or she) could not foresee this situation; so I will not follow the obsolete mission but will follow the intention of my superior." If the situation has changed completely and not even the superior's intention and operation plan are appropriate for the new situation, our soldiers must think: "When my superior developed this intention and operation plan, he could not foresee this situation. Therefore, I must consider the mission and my superior's operation plan obsolete. Instead, I must do what my superior would have ordered if he had faced this situation."

Such command and control procedures will result in chaos if those involved are not excellently trained or are not experts in their fields. Independent action can be the rule only if it is based on excellent professional skills. That is the first requirement of auftragstaktik.

The second requirement is a high degree of self-confidence. Independent action, (i.e., auftragstaktik), will develop only if—

- Soldiers consider themselves experts in their fields.
- Commanders are proud to be part of the military.
- NCOs and officers prefer their military leader assignment to anything else (and do not secretly long for an assignment in the headquarters—next to the almighties with the red general's collar patches, if possible).

The third requirement of auftragstaktik is especially difficult to meet. It concerns the superiors—up to those who personify the primacy of politics. For them, it will be possible to support (or revitalize) auftragstaktik only if they accept having subordinates who act differently from what they may have expected. If superiors intervene too often, too early or too forcefully, they may prevent a few mistakes from happening. But they will blunder because they will prevent independence from growing. Independence is the root of high combat effectiveness in a force.

Superiors must understand that, apart from lack of discipline, there is only one reason for reprimanding subordinates: inactivity or waiting for orders to come from the top. That is easier said than done. But support for or revitalization of auftragstaktik means, first, to educate superiors not to act on subordinates. It is easier to herd sheep than lions—but lions act stronger against the enemy.

The last requirement of auftragstaktik is the prevailing leadership style within the forces. For many military units, everyday business is ruled by SOPs, statistics, inspections and tests; activities are predetermined by regulations, rules and instructions. Allegedly, many military leaders are fully occupied with evaluating statements and statistics provided by subordinates, and with compiling new statistics, statements and reports. They have little time left for their most important job—to visit their troops. These visits should not be to monitor and check their troops once again but to watch and listen and learn. Officers who live in a permanently monitored environment will not develop the braveness and willingness to take the risks associated with independent action, nor will they rely on their own judgement first if this is suddenly required.

Military leaders who want their soldiers to take risks and act independently, those who want, in effect, to introduce auftragstaktik, must support its development during peacetime. They must select, promote and educate appropriate personnel and maintain an adequate level of professionalism. Military leaders who do that will obtain the desired results. They will achieve auftragstaktik, which is the willingness of soldiers to act independently and the ability to do this in a reasonable way.

Those who think auftragstaktik is nothing but a way of wording operation orders have missed the point. Those who think they can introduce auftragstaktik from above or order it to be fostered within units are like the farmer who sows wheat in the desert. There is only one way to achieve auftragstaktik: You must ignore it. Instead, you must concentrate on building forces that are intrinsically characterized by independence, maximum professional skills and confidence. In such forces, independent action will be a matter of course.

Thank you.

* * *

For more information about the concept of auftragstaktik, readers are invited to call LTC Reinhold Hocke, German liaison officer at the Engineer School, at (314) 563-4029.

Light Engineers in Urban Cordon and Search Operations

By Major Martin N. Stanton

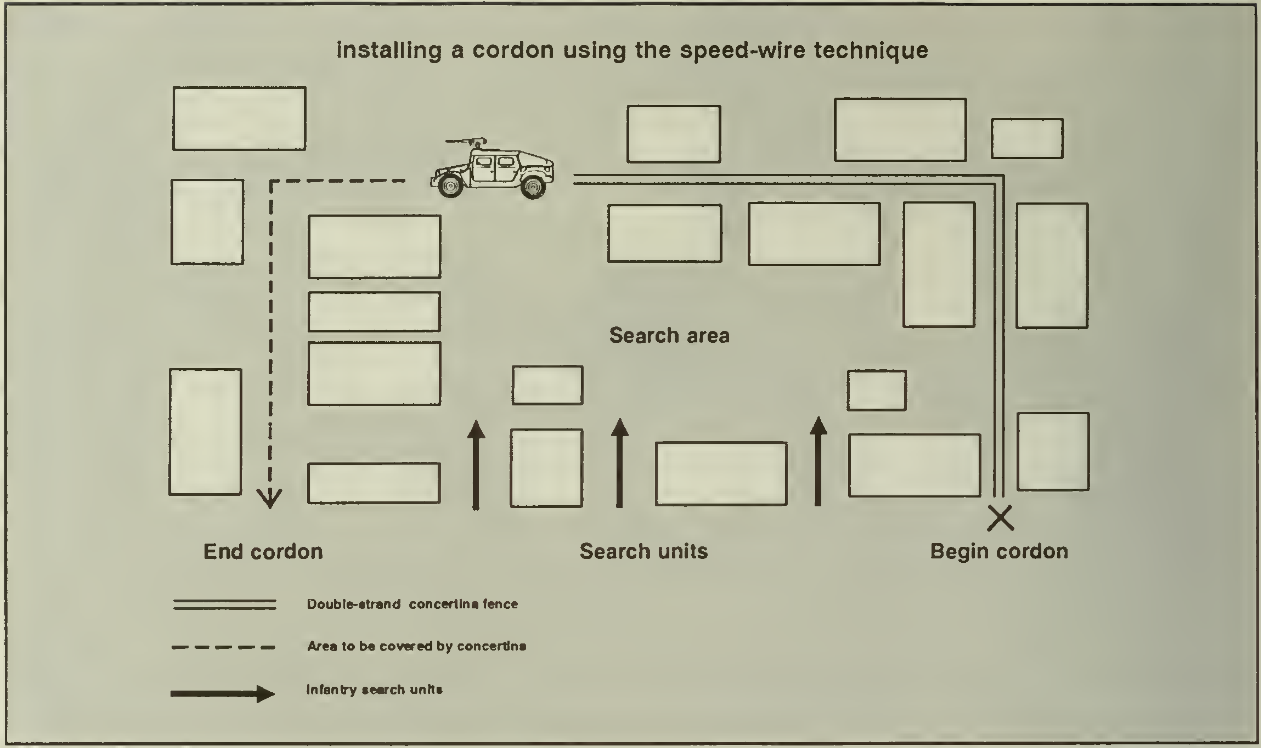
Low intensity conflict and operations other than war (LIC/OOTW) offer many opportunities for employing engineer units in innovative and unusual ways. An effective action in Somalia was the employment of a platoon from the 41st Engineer Battalion (Light) in a cordon and search operation in the town of Kismayu in February and March 1993. The platoon was attached to Task Force (TF) 2-87 Infantry.

The Situation

In a cordon and search operation, a perimeter (cordon) is emplaced around an area to prevent the escape of individuals or groups, who are the target of a search. TF 2-87 found it difficult to restrict pedestrian movement between parts of the city that had been searched for weapons and those that had not. To search the city "one bite at a time," the engineers first had to control pedestrian traffic. The rules of engagement (ROE) allowed them to fire without warning on people with visible weapons; all others had to be challenged and apprehended. Because of the large population of Kismayu (over 60,000), it was difficult to do this with the limited number of troops available (less than one battalion of Belgian paratroops and TF 2-87 Infantry). For example, while soldiers stopped one person crossing a street, a hundred others could walk by—it was not possible to stop them all. The many narrow, twisting streets in Kismayu also made it a challenge to keep people from slipping through the cordon with weapons hidden in their clothing.

The Operation

TF 2-87's solution was a technique called "speed wiring." The intent was to rapidly establish a concertina fence around the area to be searched. By creating a substantial but nonlethal obstacle, the engineers could delay the Somalis long enough to conduct a weapons search. When


Installing a cordon using the speed-wire technique
Search area
End cordon
Search units
Begin cordon
Double-strand concertina fence
Area to be covered by concertina
Infantry search units

constructing the obstacle, the engineers relied on the following tenets:

- Stealth (to allow unobtrusive emplacement).
- Speed (to prevent the Somalis from reacting to it).
- Reinforcement (to improve its obstacle value).
- Security (to prevent intentional or unintentional breaches).

The battalion operations order provided the engineer platoon leader with the boundaries for the search area and the type of obstacle to be installed. Engineers loaded trucks with enough concertina wire to create an obstacle several kilometers long. Infantry soldiers established a cordon around the search area just before daylight, and the engineers began to emplace the speed-wire obstacle.

Speed wiring required that trucks move down the road at a walking pace, while soldiers threw concertina strands out at intervals of 25 to 50 meters. Engineers walking behind the trucks spread the concertina and linked the strands together. Working quietly, they established the initial half-mile-long, side-by-side, double-strand fence in less than 15 minutes. Then, they pounded pickets in the dirt road and placed one strand of the wire on top of the other. They established exits through the fence at 250- to 300-meter intervals and posted soldiers by them to check people who tried to leave. Much like a fisherman's net, the wire obstacles allowed soldiers time to search people and to apprehend and disarm those with weapons. The engineers and an infantry platoon patrolled the fence to provide security and prevent a breach.

The wire fence was a complete success the first day it was used. Since it had been constructed quietly during the night, the Somalis within the cordon awoke to find a battalion of Belgian and a battalion of American soldiers preparing to conduct a detailed search of their neighborhood. Many of them tried to flee but were stopped by the wire. Rather than try to go through the fence, many armed young men returned to the cordoned off area to hide their weapons. The few who attempted to breach the fence were halted by engineer and infantry guards. Occasionally, donkeys or other animals became entangled in the wire and had to be cut free. The engineers watched closely to ensure that unattended children were not caught in the wire.

Associated Tasks

Search for Weapons. When searching for hidden weapons, the engineers used tools in their pioneer kits to smash locked doors and search under floorboards and above rafters. To breach doors and walls, they used the winch on their HMMWV, or they attached one end of a chain to the HMMWV's towing pintle and the other end to the door. Chain saws would have been useful to cut through doors and walls, but they were not available. A lesson learned is that units should take chain saws when they deploy on a cordon and search operation.

The engineers also used mine detectors to locate weapons hidden under piles of refuse, in dung heaps, or in fresh graves. Somalis rarely buried people with metal objects, so if the mine detectors indicated that there was metal in a fresh grave, it was almost always a weapon. The Somalis often hid weapons in such unsavory sites, hoping that the searching troops would be too squeamish to look for them. By

Task Force 2-87 captured more than 300 weapons in the cordon and search operation. The weapons reflected 50 years' of small arms development and ranged from M16s and AK47s to Bren guns and Lee Enfield rifles. They included 50-caliber machine guns, bolt-action rifles, hand and rocket-propelled grenades, mines, and mortar rounds. Some of the weapons were in good condition; others posed a greater danger to their owners than to us.

the end of the first day, the combined US/Belgian force had found almost 100 small arms and several crew-served weapons, as well as various types of grenades, mortar bombs, and antitank rounds.

Destroy Captured Weapons. The engineers used demolitions to safely destroy the weapons, explosives, and ammunition that they captured. Because the explosive ordnance disposal (EOD) personnel were occupied with more complicated demolitions or bomb disposal, the engineers were called upon to destroy captured weapons. They used demolitions to safely destroy the weapons, explosives, and ammunition that had been captured.

Construct Detainee Compounds. As armed civilians were detained, TF 2-87 planned to construct a detainee compound at the airfield base camp, thinking they would have to guard and provide for prisoners. Fortunately, the Belgians relieved the task force of this responsibility. Although the engineers did not build a compound in Kismayu, the ability to quickly erect a detainee facility is essential in this type of operation. Detainee compounds need a more secure fence than those erected for a cordon and search operation, usually one made of triple concertina or, as a minimum, double concertina intertwined with tanglefoot.

Assessing the Results

By establishing a cordon along the streets in Kismayu, TF 2-87 effectively sealed off the area to be searched. Local conditions made it easier to establish a cordon in that city than in many other urban areas: The buildings were too far apart to allow civilians to escape across rooftops, and there were no sewer systems or other subterranean avenues of escape. In urban environments with these escape routes, accurate maps are critical if the cordon is to be effective. Guarding each possible exit requires many soldiers, but if a military intelligence sensor team is available, sensors may be used in the sewers or on the out-of-the-way overhead avenues. Then the commander can maintain part of his reserve forces as a "sewer reaction force" to move to and intercept escape attempts detected by the sensors. In most urban areas, soldiers need to build nonlethal obstacles and provide security for them. These obstacles can be built with a mix of concertina, CS powder, broken glass or metal caltrops, trip flares, or even welded bars, grates, or doors. Use of lethal obstacles such as land mines is normally governed by ROE.

Making the Difference

Engineers were a key combat multiplier to TF 2-87 during the demanding cordon and search mission in Kismayu. Using limited resources, they were able to assess situations and devise plans to successfully use traditional obstacles in innovative ways. The Kismayu experience shows that leaders at all levels must be aware of engineer capabilities and constantly search for ways to use them as a combat multiplier. In Kismayu, effective employment of engineers made a significant difference in the success of the cordon and search mission.

Major Stanton, an Infantry officer, is an Assistant J5 (Policy) at the United States Army Central Command, McDill Air Force Base, Florida. Previous assignments include senior brigade advisor, Saudi Arabia National Guard; and battalion S3, 2-87 Infantry, 10th Mountain Division. He holds a master's degree in national defense and strategic studies from the Naval War College, Newport, Rhode Island.

Managing Risks Associated with Engineer Equipment

By Mark Totzke

The M9 Armored Combat Earthmover (ACE), like any new system, is being fielded with design characteristics that may pose risks to operators and equipment maintainers. Due to resource constraints, no system can be designed for perfectly safe operation under all conditions or operate in all environments and against all threats. The following information describes possible safety risks associated with the ACE and how to reduce them.

M9 ACE Accidents

As with other engineer equipment, the overall number of reported accidents involving the ACE has been low. This is because the Engineer School and most engineer units adhere to high training standards and have implemented effective risk-management programs.

Since the ACE was first fielded in 1988, several equipment operators and maintainers who failed to follow the established procedures have been involved in accidents. For example, a soldier recently had a foot amputated after it was crushed while he performed maintenance in the bowl of an ACE. He and the operator had apparently confused some prearranged hand signals, and the blade was lowered on his leg.

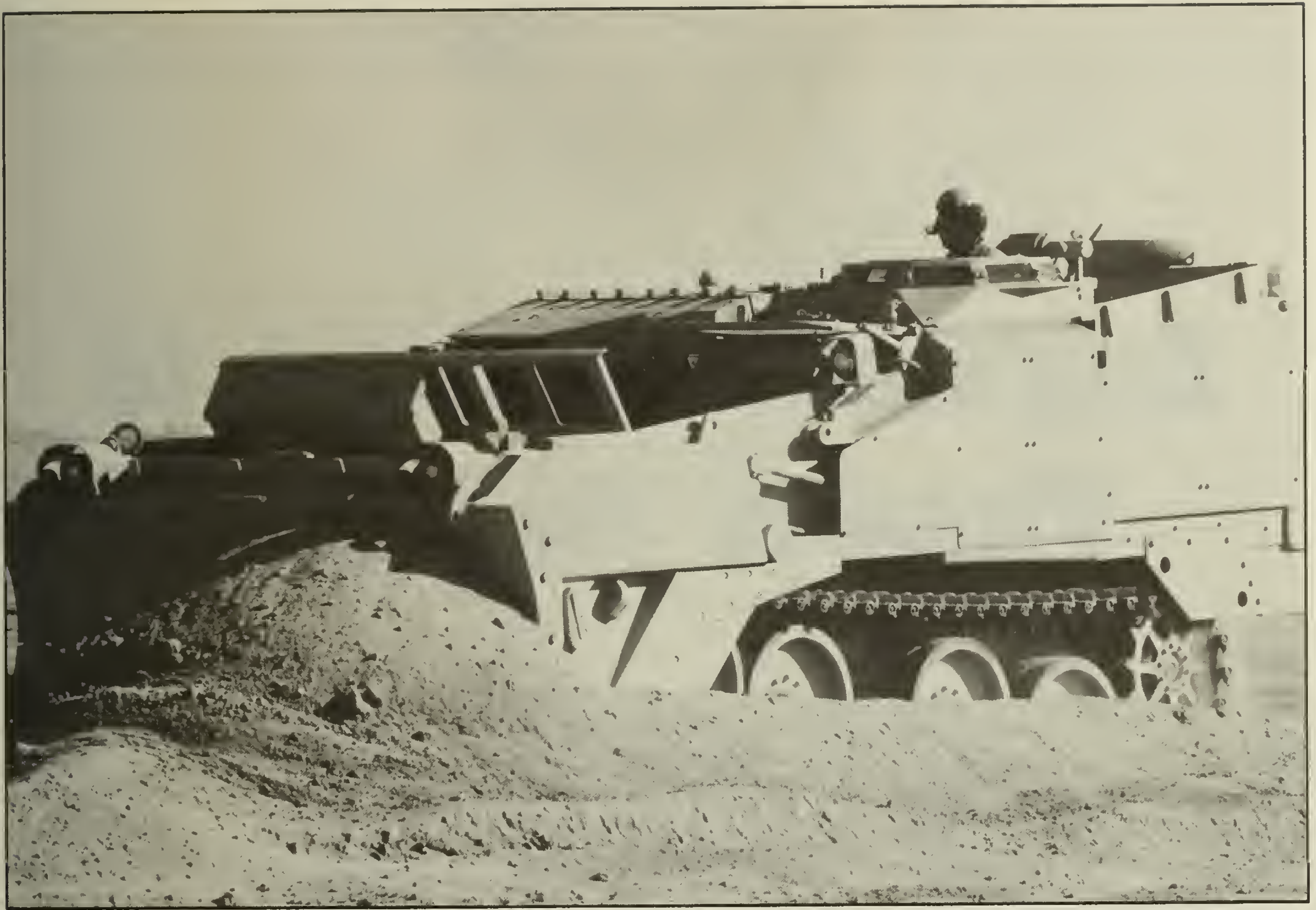
The possible occurrence of this scenario was identified during the development process for the ACE. Rather than redesign the system, however, decision makers determined that risks to soldiers would be minimized by requiring that the blade be locked in the "up" position before anyone worked in the bowl.

There are other similar, although less serious, incidents where soldiers found established procedures inconvenient and developed their own methods. For instance, soldiers often travel with the blade of the ACE down and ignore the caution to raise the blade in rough or uneven terrain. Training documents highlight this requirement, and it is reinforced in ACE training. As the post-fielding training effectiveness analysis (PFTEA) survey reveals, however, the time required to lock the blade in the up position takes from 20 to 30 minutes. This delay creates an inconvenience to mission accomplishment and the urge to take unacceptable risks. Traveling with the blade down may cause the operator to lose control of the vehicle and has raised the overall fleet costs for the ACE because of equipment damage. ACE operators and maintainers must use risk management before they deviate from the established procedures and standards, especially in this period of shrinking resources.

Risk Management Process

The key to successful risk management is to identify and implement suitable countermeasures for hazards and, for high-level risks, to allow the decision to be made by a higher authority. In the accident described earlier, the soldiers should have contacted their chain of command; then they probably would have been required to perform the operation according to established procedures.

Fort Leonard Wood's risk-management program has served as a model for use at other TRADOC schools. It combines the common sense of engineer soldiers with a systematic method to identify hazards and prevent accidents. The program enables personnel to recognize hazards in a fast-changing environment, develop appropriate countermeasures, and carry out risky operations safely.



When operated according to standard, the M9 ACE is a safe and effective piece of equipment. Here, an operator is not using the M9 ACE according to standard; he did not fill the bowl with dirt for ballast.

When developing equipment such as the ACE, the Engineer School actively participates in a system safety design effort to identify and eliminate the most serious deficiencies that may create hazards for operators and maintainers. It is a continual give-and-take process between contractors, system safety engineers, and decision makers. For nondevelopmental (off-the-shelf) materiel acquisitions, engineers conduct a market investigation to carefully compare the safety characteristics of all candidate systems. The result of the acquisition process is equipment that can complete the mission but still has inherent design flaws. Engineers compensate for these flaws through a risk-management training program that aggressively addresses all aspects of the flaws and how to overcome them.

Long before the ACE was fielded, hazards that could not be designed out of the system were translated into "Caution" and "Warning" statements in the training literature. Programs of instruction and lesson plans were developed to ensure that trainees become familiar with the equipment and have the knowledge to do their job safely. Training programs at Fort Leonard Wood are designed to ensure that soldiers are well-versed in the techniques of risk management.

Accidents involving Army personnel (military and civilian), now drain the budget of nearly $1 billion per year. In an era of shrinking resources, it is imperative that everyone learn and use risk-management procedures during their daily activities.

Readers are encouraged to call the Engineer Branch Safety Office and relate their experiences with the ACE and other engineer equipment. We want to learn about incidents that could help improve training or identify a previously unknown system deficiency. To obtain a copy of Fort Leonard Wood's risk-management regulation, write to: Commander, USAES, Attn: ATSE-CDC-S, Fort Leonard Wood, MO 65473; or call (314) 563-0131, extension 3-7346. Use the risk management process to increase the realism of training in your unit while minimizing risks to personnel!

Mr. Totzke is a systems safety engineer with the Directorate of Combat Developments and the Engineer Branch Safety Office, U.S. Army Engineer School. Mr. Totzke holds bachelor's degrees in mining and general engineering from Sourthern Illinois University and the University of Illinois.

Engineer Support to Theater Aviation

By First Lieutenant Amy Klopotoski and Sergeant First Class Timothy J. Funk

Topographic surveyors deploying to the battlefield provide precise-positioning data (latitude, longitude and elevation) to many users. Army users of topographic information include Command and Control, Field Artillery, Air Defense Artillery, Signal, Military Intelligence and Army Aviation.

The survey platoon from the 29th Engineer Battalion in Hawaii is the only Active Component topographic survey unit in the Pacific theater. The platoon focuses on wartime missions and technical readiness through varied training exercises. Once each quarter it deploys with division artillery units to practice quick-response, precise-positioning skills.

SPC Gatling observes an angle while PFC Gambos records the angle from high atop a hanger at Bryant Army Heliport, Fort Richardson, Alaska.

The platoon's most recent challenge was a two-month deployment to Alaska. It's mission was to complete safety and navigational aid (NAVAID) surveys for three U.S. Army airfields: Allen Army Airfield at Fort Greely, Wainwright Army Airfield at Fort Wainwright, and Bryant Army Heliport at Fort Richardson. On the surveys, the platoon positioned the airfield's NAVAIDs, identified nearby obstructions and established the airfield elevation. This was done to comply with a Federal Aviation Administration (FAA) requirement that safety and NAVAID surveys be conducted on all U.S. airfields every five years.

Although the deployment was projected to last three months, the survey platoon completed the job in two months, at a considerable cost savings. Support received from organizations throughout Alaska contributed to the mission's success.

Using military personnel to do the three surveys cost about $90,000. In comparison, hiring an outside contractor would have cost about $200,000 for each airfield. Compared with the cost of hiring contractors, deploying Army topographic surveyors for the mission was a minimal expense, and the experience provided outstanding training for soldiers.

The Alaska project offered the survey platoon an opportunity to simulate a real-war mission combined with real-deployment considerations. One month before the platoon deployed, a reconnaissance (recon) team was sent to the three airfields. It determined the scope of required support, including billeting and transportation. The recon team also located existing survey control points on and around the airfields. These were points where the horizontal and vertical positions were determined to a high degree of accuracy. Data for these points exist in files called *trig* lists; they include station description cards and survey control schematic diagrams.

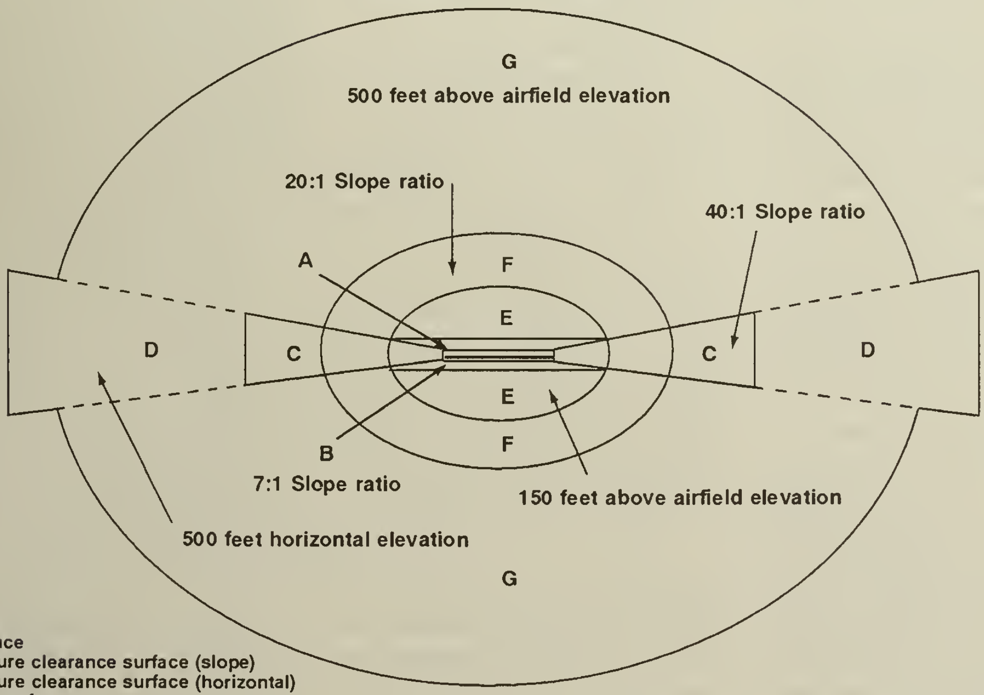
During the recon, the team requested trig lists from many sources, including the Army Corps of Engineers, Alaska District; the State Bureau of Land Management; and the University of Alaska-Fairbanks. The trig lists described where to locate the points using local reference marks such as roads or buildings, many of which were established in the early 1940s. At Fort Greely, a rural undeveloped area, the surveyors found the points relatively easily. However, at the other two airfields, located near the growing cities of Fairbanks and Anchorage, some points were difficult to find.

Upon arrival at Allen Army Airfield, the surveyors task organized into two crews: the level crew and the Global Positioning System (GPS)/observation crew. Crew members rotated to different jobs on each airfield to gain experience in different surveying skills.

The level crew recovered and verified vertical control points (benchmarks). Before using a control point in a survey, the surveyors checked the trig data to ensure that the point had not shifted since it was emplaced. Then, they used differential leveling methods to determine the elevation of various points on the runway. Starting at one benchmark, the level crew ran a continuous level line through the airfield and closed on a second benchmark. They established the elevation on each end of the runways and every 100 feet down the centerline of the runways. They ran spurs off the main level line to establish elevations on the three airfields' barometers.

The GPS/observation crew recovered and verified horizontal

Imaginary Surfaces


G
500 feet above airfield elevation
20:1 Slope ratio
40:1 Slope ratio
A
F
E
D
C
C
D
E
B
F
7:1 Slope ratio
150 feet above airfield elevation
500 feet horizontal elevation
G

A Primary surface
B Transitional surface
C Approach-departure clearance surface (slope)
D Approach-departure clearance surface (horizontal)
E Inner horizontal surface
F Conical surface
G Outer horizontal surface

Figure 1

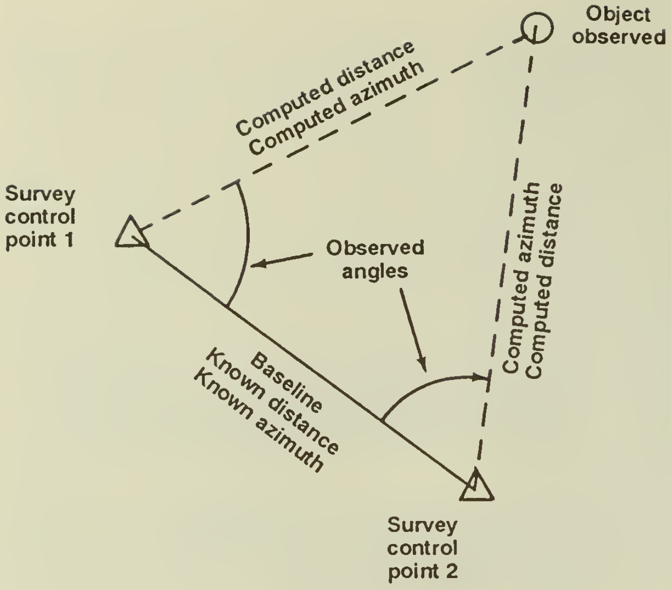


Figure 2. Intersection

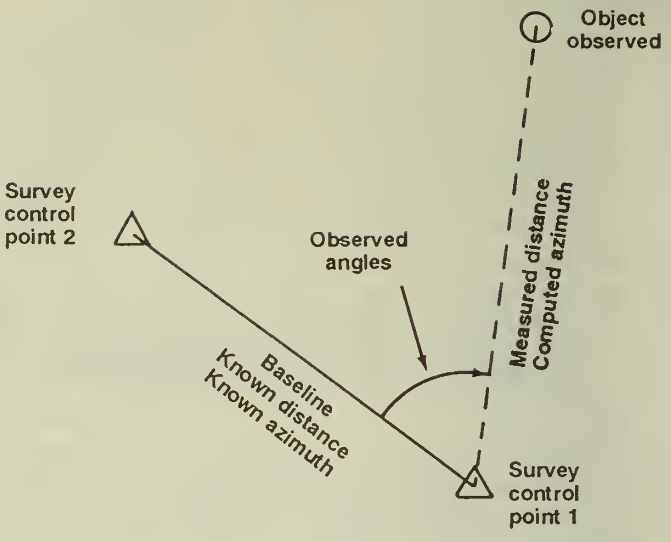


Figure 3. Sideshots

survey control points. Verification of the points was accomplished using the static GPS surveying method (see insert) to determine the position; then the points were compared to data in the trig list. After verifying three horizontal points, they used the points to establish more control points on the airfield. The crew observed all of the airfield obstructions and NAVAIDs at those control points. They determined airfield obstructions by drawing imaginary surfaces on a topographic map at various heights above the airfield elevation, as shown in Figure 1. The surfaces extended approximately 10 nautical miles in all directions from the airfield runways.

After establishing control points with geodetic-quality GPS receivers, the GPS/observation crew used conventional surveying methods to provide precise horizontal positioning for the obstructions and NAVAIDs. The two methods used to determine positioning were intersection and sideshots (Figures 2 and 3).

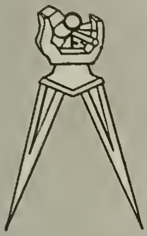
On two of the airfields, the surveyors employed a third method of positioning, using a GPS surveying method called *pseudo-kinematic surveying and processing.* The GPS receivers employed the method in a rapid surveying mode. Keeping two receivers on known positions and the third receiver roving from point to point, the surveyors quickly positioned many NAVAIDs on the airfields. Then they positioned the roving receiver directly over the NAVAID and collected data for 8 to 10 minutes at each position. They repeated the process one hour later.

The airfield surveys were time consuming and occupied several sites on each airfield, including the runways. The airfields could not shut down during the survey, so the survey team chief maintained constant coordination with the survey teams, airfield operations and the control towers. When a control tower was closed, the surveyors kept one eye looking through their instruments and the other eye on the sky because they usually shared the runways with C-12 aircraft or helicopters.

After the field data were collected, the surveyors converted their field notes to abstract sheets, which they used for position computations. The surveyors used a computer program that calculated positions faster than they could have calculated them manually. These programs were written by Sergeant Terry Klock, a topographic surveyor formerly assigned to the 29th Engineers.

Back at Fort Shafter, the surveyors compiled the data and created an airfield Obstruction Chart (OC), the final product. It was sent to Army Aviation at Cameron Station, Virginia, for approval. While drafting the OC according to specifications can take as long as the field work, a computer-aided design system (CADS) speeded up the drafting process by allowing them to store the drawing digitally. The automated database they created for each airfield now can be updated easily every 5 years.

The Alaskan project was cost effective and it allowed soldiers to receive intense training in both satellite and conventional surveying methods. The soldiers' enthusiasm and up-to-date techniques helped them achieve accurate results and complete the surveys ahead of schedule. In light of budget reductions and downsizing, providing soldiers opportunities to work in their trained areas benefits both the soldiers and the Army.



Surveying with the Global Positioning System

Most soldiers in the Army use GPS receivers to assist them in navigating from one point to another. Only a few soldiers know they also can use geodetic-type GPS receivers to determine the position of any point on the earth's surface within millimeters.

To use the method, called static GPS surveying, the antenna of a geodetic-type receiver is plumbed over a known control point, and two or more other receivers are plumbed over the points to be established. All of the receivers then simultaneously collect data for one to two hours from at least four satellites. The collected data from all of the receivers are downloaded into a computer; and the azimuth, the distance and the difference in elevation (baseline vectors) are computed between the stations using GPS data processing software. These vectors are applied to the known position and then adjusted using "least square" adjustment software. This software produces an adjusted position relative to the known position that is based on the user's requested datum. (Datum is the point-of-origin and orientation on an ellipsoid for a specific set of survey control.)

By using the GPS method, topographic surveyors can locate positions more accurately and in a fraction of the time it would take using conventional surveying methods.

SGT Long checks the placement of a Global Positioning System antenna positioned on an approach light at Wainwright Army Airfield. The surveyors used pseudokinematic surveying procedures to determine the precise position of the lights.

References

Field Manual 5-232, *Topographic Surveying,* 1989.

Technical Manual 5-232, *Elements of Surveying*, 1971.

Department of Defense Publication *Glossary of Mapping, Charting and Geodetic Terms*, 1981.

U.S. Army Corps of Engineers Publication, *NAVSTAR Global Positioning System Surveying*, Engineer Manual 1110-1-1003, 14 June 1993.

Federal Aviation Administration Publication 405, *Specifications Airport Obstruction Chart and Related Products*, February 1986.

First Lieutenant Amy Klopotoski is the executive officer for Headquarters Company, 29th Engineer Battalion. She previously served as survey platoon leader, 29th Engineer Battalion. 1LT Klopotoski is a graduate of the Engineer Officer Basic Course and the Mapping, Charting and Geodesy Officer's Course. She holds a bachelor's degree in journalism from Syracuse University.

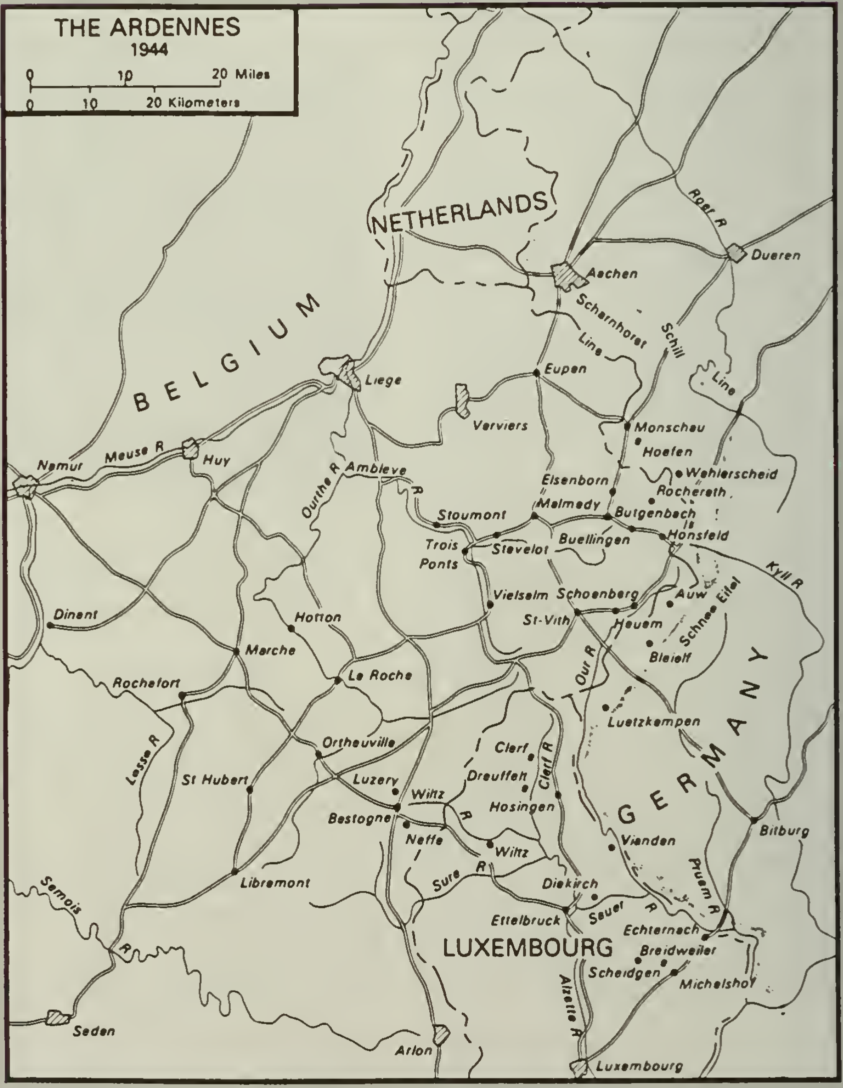
Sergeant First Class Timothy J. Funk is a training developer at the U.S. Army Engineer School, Fort Leonard Wood. He served as the platoon sergeant of the survey platoon, 29th Engineer Battalion, and led his squad in the first use of GPS surveying in combat during Operation Desert Storm. SFC Funk is a graduate of the Advanced Noncommissioned Officer Course and holds an associate's degree from Hawaii Pacific University.

Engineers and the Battle of the Bulge

By *William C. Baldwin*

December 1994 is the 50th anniversary of the Battle of the Bulge. During that battle, American and Allied forces turned back Hitler's last great offensive in western Europe. Often fighting as infantry in desperate circumstances, engineers played a critical role in the early days of the offensive. One of their major contributions was to delay German armored columns long enough for Allied units to set up defensive positions. The engineers' experience in the Bulge demonstrated that engineers must always be prepared for any unexpected missions a combat situation may thrust upon them.

Although D-Day landings on June 6, 1944, gave the western Allies a beachhead in northern France, it took almost two months of bitter fighting to break out of Normandy's hedgerows. After the breakout, Allied armies raced across France, liberated Paris and headed toward the German frontier. The severe strain that the rapid advance placed on Allied logistics, along with bad weather and stiffening German resistance, eventually slowed the offensive. By mid-December 1944, American armies had reached the Roer River inside Germany and the West Wall along the Saar River in eastern France. Between these two fronts lay the Ardennes, a hilly, densely forested area in eastern Belgium through which the Germans had attacked France in 1940.



Five American divisions and a cavalry group held the 85-mile-long Ardennes front. The difficult terrain and the belief that the German army was near exhaustion convinced the Allied commanders that the Ardennes sector was relatively safe. Thus, three of the divisions were new, and the other two were recuperating from heavy losses suffered in the Huertgen forest.

After months of retreat, Hitler decided on a bold gamble to regain

Engineers sweep for mines in the snow during the Ardennes campaign.

the initiative in the west. Under the cover of winter weather, the Germans massed large forces opposite the Ardennes. They planned to crash through the thinly held American front, cross the Meuse River and drive to Antwerp. Before daybreak on December 16, the German army launched its last desperate offensive and completely surprised the Allies.

As the American front in the Ardennes collapsed, the Allies redeployed their forces to fill the gap. While these troops were moving into position, the Army had to rely on rear area troops already in the Ardennes. Many of those units were corps and Army engineer battalions that were scattered throughout the area in company-, platoon- and even squad-sized groups. Engineers who had been engaged in road maintenance and sawmilling operations suddenly found themselves manning roadblocks and preparing defensive positions in the face of powerful German armored columns. Many engineer units played important roles in the Battle of the Bulge, but the following vignettes show how those engineers imposed critical delays on the offensive forces, whose only hope for success lay in crossing the Meuse River quickly.

Lieutenant Colonel Joachin Peiper, a Nazi SS officer, led one of the armored columns. His route went near the town of Malmedy and toward the villages of Stavelot and Trois Ponts. The headquarters of the 1111th Engineer Combat Group was in Trois Ponts, and one of its units, the 291st Engineer Combat Battalion, had detachments working throughout the area. When he learned on December 17 of the German breakthrough, the commander of the 1111th Group sent Lieutenant Colonel David E. Pergrin, the 27-year-old commander of the 291st, to Malmedy to organize its defense.

Although most of the American troops in the area were fleeing, Colonel Pergrin decided to hold his position in spite of the panic and confusion. He ordered his engineers to set up defensive positions around the town. During the afternoon of the 17th, engineers manning a roadblock on the outskirts of Malmedy heard small arms fire coming from a nearby crossroads. Then terrified American soldiers staggered up to the roadblock. They brought word of the Malmedy massacre, in which Peiper's troops murdered at least 86 captured American soldiers.

Bypassing Malmedy, Peiper headed toward Stavelot, where Colonel Pergrin had sent another detachment of the 291st. Equipped with some mines and a bazooka, the engineers and some armored infantry soldiers delayed the German column for a few hours, but the small American

A soldier from the 51st Engineer Combat Battalion checks a TNT charge on a tree during the Battle of the Bulge.

force was no match for the panzers. Peiper's column pushed through the village, and its lead tanks turned west toward Trois Ponts.

Shortly before the Germans broke through the roadblock at Stavelot, Company C of Lieutenant Colonel Harvey Fraser's 51st Engineer Combat Battalion, also part of the 1111th Group, received orders to defend Trois Ponts. Reinforced by an antitank gun and a squad of armored infantry, the company prepared bridges for demolition. When Peiper's tanks came into view, the engineers blew up the main bridge leading into the village.

By the evening of December 18, the small American force at Trois Ponts had come under the command of Major Robert B. Yates, executive officer of the 51st, who had come to the village expecting to attend a daily staff meeting. Fearing that the Germans would discover the weakness of his force, Major Yates tried to deceive the enemy. During the night, the engineers repeatedly drove the company's six trucks into Trois Ponts with their lights on and drove out with their lights off to simulate the arrival of reinforcements. They put chains on their only four-ton truck and drove it back and forth through the village to create the impression that they had tanks. An American tank destroyer, which had slipped into the river a few days earlier, provided the artillery. It caught fire and its shells exploded at irregular intervals throughout the night. The ruse apparently worked, because the Germans never launched a determined attack on the village.

On December 20, the 82nd Airborne Division, which was trying to block the German penetrations, learned of the small force holding Trois Ponts. When the paratroopers moved into the village, Major Yates greeted their commander with, "Say, I'll bet you fellows are glad we're here!" American troops eventually destroyed Peiper's armored column.

Farther south, engineers were also caught in the massive German attack. On December 17, the VIII Corps commander ordered his 44th Engineer Combat Battalion, under Lieutenant Colonel Clarion J. Kjeldseth, to drop its road maintenance, sawmilling and quarrying operations and help defend the town of Wiltz, in Luxembourg. The 600 men of the 44th joined a ragtag force consisting of some crippled tanks, assault guns, artillery and divisional headquarters troops. Attacked by tanks and infantry on December 18, the engineers held their fire as the tanks roared by and blasted the German infantry following behind. Forced to retreat by the weight of the German attack, the defenders moved back into the town and blew up the bridge over the Wiltz River. By the next evening, the small American force was surrounded and running low on ammunition. The soldiers attempted to escape but few made it back safely. Among the heavy American casualties was the equivalent of three engineer companies dead or missing. The defenders of Wiltz, however, had slowed the German advance and given other American troops time to rush to the defense of a critically important crossroads some 10 miles to the west—the town of Bastogne.

With the American defenses west of Bastogne collapsing, the corps commander ordered the last of his reserves to defend Bastogne until reinforcements could arrive. The reserves included the 35th Engineer Combat Battalion, a corps unit, and the 158th Engineer Combat Battalion, an Army unit which happened to be working in the area. On the morning of the 19th, German tanks attacked an engineer roadblock in the darkness. Unsure of his target in the gloom, Private Bernard Michin waited until the German tank was only 10 yards away before firing his bazooka. The explosion knocked out the tank and blinded him. As he rolled into a ditch, Private Michin heard machine gun fire close by. He threw a grenade at the sound, which ceased, and struggled back to his platoon. Private Michin, who regained his sight several hours later, received the Distinguished Service Cross for his bravery under fire. During the evening of the 19th and the morning of the 20th, the 101st Airborne Division, which had rushed to the defense of Bastogne, relieved the 158th and the 35th Engineer Combat Battalions. German panzers and troops continued to push west and north of Bastogne, and eventually surrounded the American defenders in the town.

Throughout the Ardennes, divisional, corps and Army engineer units participated valiantly in a sometimes desperate attempt to stem the tide of the unexpected German counteroffensive. Relying on their initiative and training in defensive operations, Army engineers established roadblocks with whatever troops and weapons were at hand. They blew up bridges, planted minefields and succeeded, often at the cost of heavy casualties, in delaying the powerful German armored columns. The delays that the engineers helped to impose gave the Allies time to bring in reinforcements and seal off the German penetrations. The Battle of the Bulge demonstrated that engineers could make a major contribution to the outcome of an important campaign.

William Baldwin is a historian in the Office of History, Headquarters, U.S. Army Corps of Engineers, Alexandria, Virginia.

ENGINEER UPDATE

Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

Environmental Handbook and Video. Two new tools have been developed to assist company-level leaders with environmental responsibilities. Training Circular (TC) 5-400, *Unit Leaders' Handbook for Environmental Stewardship*, was distributed in September 1994. The handbook contains recommendations to ensure compliance with Army environmental goals and policies, as well as federal, state, and local laws and regulations. Called the "Dash 10" manual, it delineates before, during and after checks for units conducting a field training exercise (FTX).

A case-study video and lesson plan will promote environmental ethics, unit environmental operations, and use of TC 5-400. The video's four segments highlight compliance programs and how to conduct before, during and after-action environmental checks during an FTX. The video is scheduled for distribution to TASC offices in April 1995. POC is CPT Richard Heitkamp, -4122.

ENGINEER Mail-List Update. Thanks are extended to those who have responded to the ENGINEER mail-list update letter we distributed in October. Responses are used to correct addresses and to adjust the number of magazines distributed. Units that have not yet responded are encouraged to return the entire letter, even if there are no changes to report. To request an update letter, call (314) 563-4104. POC is Catherine Eubanks,-4104.

Directorate of Evaluation and Standardization (DOES)

M9 ACE Post Fielding Training Effectiveness Analysis (PFTEA) Report. Copies of the PFTEA report were sent to all Army and Marine Corps units owning the M9 ACE in November. The report contains survey results and comments from ACE operators, mechanics, supervisors and unit commanders. Additional copies may be obtained by calling Ms. McAvenia, at (314) 563-4009. POC is Vern Lowrey, -4007.

Engineer Personnel Proponency Office (EPPO)

Warrant Officer Basic Course Extended. Starting with Class 05-95, 6 January 1995, the 919A Warrant Officer Basic Course at Fort Leonard Wood will be extended from 11 weeks to 17 weeks. The extended class will provide additional training in diagnostics, troubleshooting, battlefield damage assessment and repair, and case studies. POC is Mr. Mello, (314) 596-0837.

Reserve Components (RC)

Reserve Component Combined Arms and Services Staff School (R-CAS3). Reserve, National Guard, and Title 32 AGR officers in the Fort Leonard Wood area may now attend CAS3 in a centralized location. CAS3, now required for promotion to major, is available through the 5038th USARF School satellite unit. Class 94-03 began 5 November. Eligible officers completed the Phase I correspondence course before the schoolhouse phase. After eight weekend drills and two weeks at Fort Leavenworth, they will be CAS3 graduates and will have fulfilled their required professional education for promotion to major.

Other changes to academic requirements for enrollment in the Command and General Staff College include grade of major and completion of CAS3. This makes CAS3 the hingepin for future successful careers and an important professional milestone. POCs are LTC Jim Smith, -4085 and LTC Herb Hiatt, (314) 774-5645 or (314) 596-0302.

News and Notes

Department of Defense Fire Protection School. The new Department of Defense Fire Protection School, at Goodfellow Air Force Base, Texas, will officially open on 19 January 1995. The school currently trains military and civilian Air Force, Army and allied forces personnel. Marine Corps personnel are scheduled to participate beginning in October 1995. Course graduates receive DOD ceritfications ranging from entry-level fire fighter through the supervisory level of fire chief. In addition to classrooms and equipment storage facilities, the school has a state-of-the-art live fire training area, a training tower/residential burn building, and a fire truck maintenance facility. POC is SFC Robin Compton, (915) 654-4827 or DSN 477-4827.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

Reflections

As I look back on my last two years as command sergeant major of the Engineer Center and reminisce about my initial excitement, enthusiasm, anxiety and anticipation for this position, two early goals come to mind: Improve two-way communication between the Engineer Center and field units, and ensure that the quality of training taught at Fort Leonard Wood is realistic, tough, and above all, safe.

To improve communication with field personnel, I have visited about 80 percent of our engineer units, both CONUS and OCONUS. After meeting with unit leaders and soldiers, I brought their concerns back to the Engineer Center for resolution. The Senior Engineer Leaders Training Conference (SELTC), held each April at Fort Leonard Wood, has helped improve communication. There, senior leaders from all units meet to discuss personnel, equipment, training, and doctrinal issues. Afterwards, Engineer Center personnel work diligently to fix problems bought to our attention at the conference. The improved communication is achieving benefits for the entire engineer community.

The quality of training at Fort Leonard Wood continues to be tough, realistic, and safe. To improve training effectiveness, the Engineer School's Directorate of Training (DOT) has recently reorganized. The DOT has three departments that are responsible for the development and execution of training. The Department of Tactics and Leadership is responsible for the Engineer Officer Basic and Advanced Courses and warfighting training. The Department of Combat Engineering is responsible for career management field (CMF) 12 training; and the Department of Construction Engineering is responsible for CMFs 51 and 62 training. They are working hard to ensure that high quality, tough, realistic and safe training is conducted in all programs of instruction.

Of the many other initiatives put forward during my tenure here, I will review three:

Unit Training and Equipment Improvements. Engineer School personnel are working to resolve the low operational readiness rates of the Combat Engineer Vehicle (CEV), the Armored Vehicle-Launched Bridge (AVLB), and the Armored Combat Earthmover (ACE) vehicle fleets. We are working closely with equipment managers at the Tank Automotive Command and training developers and trainers here to resolve problems through improved parts availability, equipment upgrades and better training strategies. I'm confident that our efforts will have a positive effect on equipment readiness.

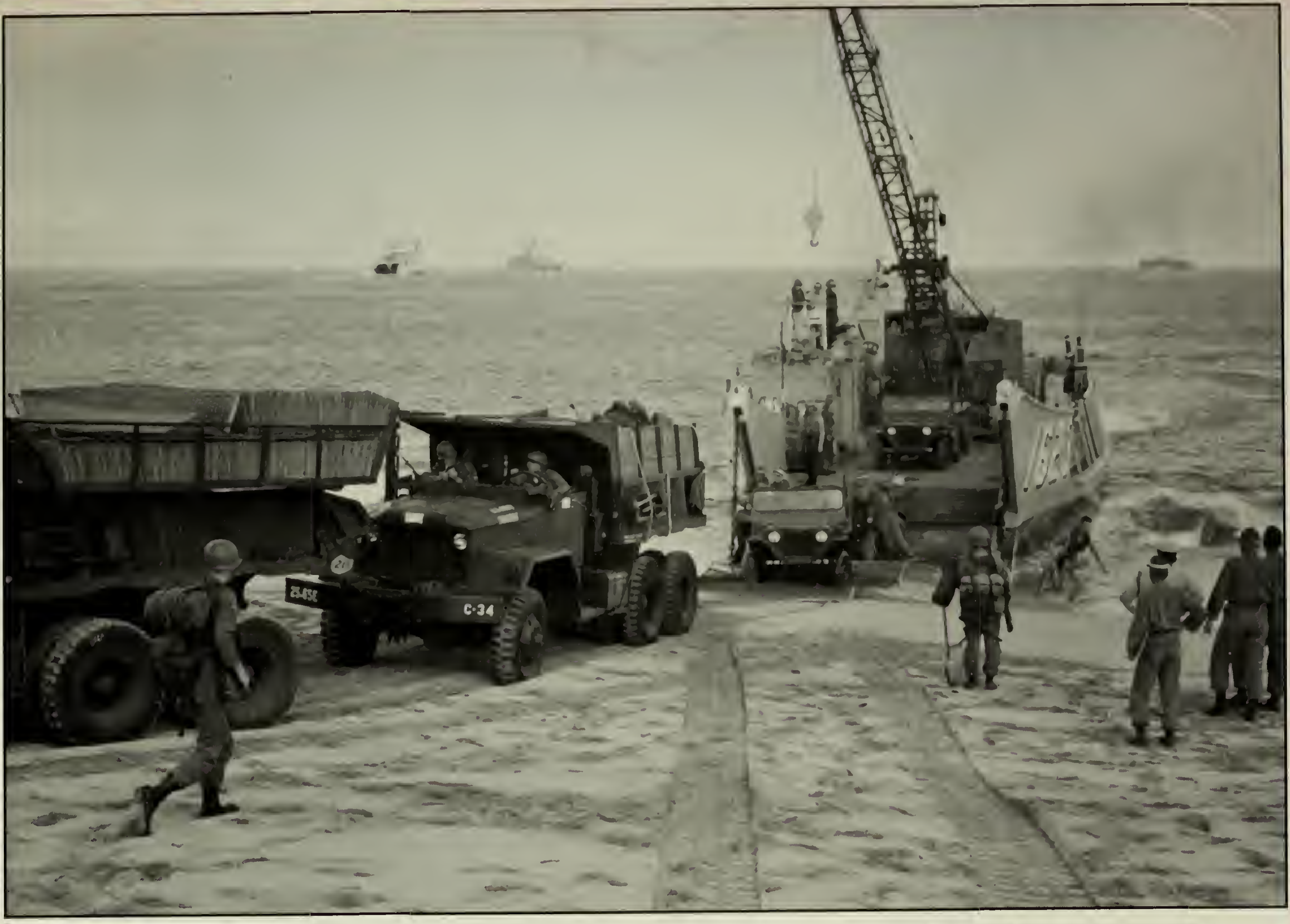
New Equipment. The Engineer Center is working to procure several new engineer systems, including:

- The Grizzly (formerly called the Breacher). It is an M1 chassis-based breaching system that will replace the CEV fleet on a two-for-one basis. The first unit equipped is scheduled for fiscal year (FY) 99.
- The Wolverine (formerly the Heavy Assault Bridge (HAB). Another M1 chassis-based system, it will launch a 24-meter, military load class 90, Leguan-type bridge. The first unit equipped is scheduled for 2000.
- The Improved Common Bridge Transporter. This modified M977 HEMTT chassis will be used to transport the ribbon bridge. The system will be a one-for-one replacement of current bridge transporters. Fielding will begin in FY 96.

These are a few of many systems being procured to ensure that engineer soldiers have the best equipment possible to accomplish their missions.

Personnel Issues. The drawdown has affected engineers as it has everyone in the Department of Defense, but we are working diligently to lessen impacts on the engineer force. One initiative is to consolidate military occupational specialties (MOS) wherever possible. We have consolidated MOS 51G (materials quality specialist), 81B (construction draftsman) and 82B (construction surveyor) into MOS 51T (engineer technician). We are now working to roll MOS 12F into MOS 12B. The aim is to eliminate the low density 12F MOS and improve opportunities for advancement. We have also opened the enlisted and noncommissioned officer specialties of MOS 12C (engineer bridge crewman) and 12Z (combat engineer senior sergeant) to women. This was done to provide continued promotion and assignment availability to women, while meeting the needs of the engineer force.

I have learned much in the last two years, but one thing stands out. The Engineer Center is here to help engineer units resolve their equipment, training, doctrine and personnel issues, and to establish the regimental azimuth for the future. Let us hear from you!



The 65th Engineer Battalion, 25th Infantry Division; 299th Infantry, Hawaii National Guard; and the 1st Marine Brigade train together in West Wind, a brigade-size, joint services, amphibious landing exercise. This counterinsurgency anti-guerilla operation on the island of Molokai took place in April 1964.

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Force XXI

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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

The Engineer Regiment of tomorrow will meet the challenges of the 21st century by leveraging technology to strengthen its capability as a vital and viable member of the combined arms team. This is an important and exciting process—we must transform virtually all areas of our battlefield operating system while sustaining the combat readiness of our current force.

The regiment's vision looks beyond the force structure reductions and resource constraints of today. It captures the spirit of Force XXI and positions engineers as a critical component of the future Army—the "terrain shapers" of the 21st century. (See article beginning on page 2.) To realize this vision, we must continually "push the envelope" to make changes mandated by the new ways in which we view the world, the threat, and our maneuver-support missions. We must develop new doctrine and operational concepts that exploit emerging technologies and advancements in the art and science of battle command.

Our Army and regiment have already accomplished significant force reductions and restructuring. These changes continue with the drawdown of the TOE Active Component force to ten divisions and the 1995 round of BRAC cuts and reorganizations. The Engineer Center and Fort Leonard Wood will continue to pursue, as a top priority, the optimal mix of personnel, training, and equipment resources; concepts; and functions required to enhance the readiness of our force. Concurrently, we will lay the groundwork for our key position on the Force XXI team.

Your regiment is now in a crucial stage, that of redesigning the force. Although affected by decreasing budgets and manpower reductions, these influences cannot drive the train. We must prepare to engage head-on the terrain visualization and shaping (mobility, countermobility and survivability included) missions of a smaller, more lethal force-projection Army. A genuine challenge to regiment leaders is to break the paradigms of the Army of the 1990s. Using the DTLOMS (doctrine, training, leader development, organization, materiel, and soldiers) model, we must think "outside the box" to help shape the engineers' roles, functions, concepts and systems needed by the high-tech Army of the 21st century. This year's Engineer Commanders' Conference, formerly SELTC, is the line of departure for this process.

The 1995 conference will be the first to concentrate on the roles, missions, and structure of Force XXI engineers. Called the Engineer Force XXI Conference (ENFORCE XXI), 25-29 April 1995, it will not be a typical branch conference for commanders to compare notes, hear speeches, and socialize. Although these opportunities will be provided, ENFORCE XXI will incorporate a hands-on process that pursues the operational concepts and design of the future engineer force at all echelons. Activities will focus on meeting the land-warfare requirements of the 21st century combined arms team. The regiment will seek to enhance its capability as a lethal, versatile combat multiplier while standing ready to support disaster relief and humanitarian missions around the world within the spectrum of operations other than war.

At ENFORCE XXI, engineer leaders will participate in field training through four engineer warfighting demonstrations, which will showcase technological advances that predicate changes throughout the DTLOMS spectrum. The demonstrations, early entry and lodgement, heavy/light operations, own the water, and mounted battle space/battle command, are described in an article beginning on page 11 of this issue of *ENGINEER*. After participating in these demonstrations, engineer leaders will meet in workshops to discuss the future of our regiment. Their ideas and points of view will contribute to the process of defining and directing future engineer roles, missions and concepts. We must, as a team, determine what changes are needed across the DTLOMS spectrum to ensure optimal support of the Force XXI Army.

Distinguished speakers at the conference will promote the theme and challenge our minds. Speakers include the Army Vice Chief of Staff, the TRADOC Commander, the Combined Arms Center Commander, the Chief of Engineers, the Armor Center Commander, and the Infantry Center Commander. As always, the conference will provide an opportunity for the military engineering community to focus efforts and resolve key issues. ENFORCE XXI will bring together again our exceptionally talented and resourceful team of engineer commanders, command sergeants major, and Department of the Army civilians. Let's make this event count as a constructive step closer to the engineer force of the future—ENFORCE XXI!

ESSAYONS!

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FORCE XXI

Shaping Force XXI Engineers

By Members of the Engineer School Task Force XXI

It had been a long night while his platoons worked feverishly to prepare the defense. Now, at 0330 hours, the engineer company commander looked up to see the first enemy elements appearing over the southern ridge line. He knew the entire task force was viewing the same picture, not through binoculars but on monitors depicting near real-time enemy movement that was digitally reported by division and corps intelligence assets and transmitted throughout the task force. The enemy appeared as icons on a topographic line map background. Just 24 hours earlier, one of his squads had conducted a route reconnaissance using their terrain reconnaissance tool (TRT) to update the compact disk map-background data used by all members of the task force. Using the TRT, it had taken only an hour to collect the information and digitally transmit it to the division's terrain team. That team digitally transmitted it throughout the division and to other friendly units. During their mission planning and rehearsals, task force commanders had relied on the updated digital map, which showed the new bridge and road network leading into the task force's defensive sector.

The enemy seemed to be attacking with unexpected strength. Fortunately, his second platoon leader had emplaced hunter-killer teams along the route and they had rehearsed this contingency. To reassure himself, the commander clicked on two buttons beneath his monitor and pulled up both the obstacle overlay and the friendly locations. All was set. The digital FRAGO and overlay that all task force commanders were now receiving confirmed his notions. His second platoon leader, who had also received the FRAGO, began to execute the mission change by reconfiguring the hunter-killer teams. These electronic sensor teams, actually intelligent minefield clusters, were now beginning to monitor enemy movement. The minefield originally had been intended to disrupt enemy maneuver in the enemy's path. Now the platoon leader sent a signal to the minefield of internetted, communicating wide-area mines and munitions. The signal would reconfigure the minefield for a fixing obstacle, as directed in the FRAGO.

Force XXI engineers will add new multidimensional capabilities to the combined arms force. The above scenario provides a glimpse of future knowledge-based engineer operations. The Engineer School is moving along several fronts to form an engineer corps that can fight and win on the digitized battlefield.

Battlefield Digitization

A "digitized battlefield" has technologies that all elements of the force use to acquire, exchange, and employ timely digital information. Digitization allows deciders, shooters, and supporters at all levels to maintain a clear and accurate vision of their battlespace to support both mission planning and execution. Graphical displays present a common picture for all users so they share situational awareness. From this vantage point, a commander gains the ability to employ forces and resources in a highly mobile, synergistic, and efficient manner.

Digitization technology enhances operations across the organization. Technically, it uses and integrates modern processing and display systems, communications, position/navigation systems (such as the Global Positioning System [GPS]), combat identification, sensor components, and distributed data-base management. Force elements transmit streams of digital data to create seamless connectivity across national, theater, and tactical grids. Operationally, this technology provides a clear and accurate picture of the battlefield. Army forces achieve this shared situational awareness in part through self-location/navigation and in part through friendly and enemy force tracking. Digitization technology aids force synchronization, reduces fratricide, and enables greater efficiency in target and obstacle integration. All elements of the force benefit.

From an operational perspective, digitizing the battlefield helps to create a synergistic effect through near real-time command and control. It yields an overwhelming operational tempo that is faster than the enemy's ability to react. Simulations show that digital capability, such as on-the-move FRAGO processing, increases tactical tempo and improves lethality and survivability.

We are applying digitization technologies in the engineer force in concert with other members of the combined arms team to form the future Force XXI Army.

Force XXI Campaign Plan

General Sullivan's vision of the Army that will fight on the digitized battlefield is Force XXI:

> *Force XXI is the reconceptualization and redesign of the force at all echelons, from the foxhole to the industrial base, to meet the needs of a volatile and ever-changing world. It will be a force organized around information and information technologies. Its purpose will be to deter those who oppose us, to compel when deterrence fails, and to reassure our friends and allies around the world that they can count on us.*[1]

The central feature of Force XXI is its ability to exploit information.To win the information war, the total force requires a mature digitization capability.

The Army's campaign plan provides the construct to achieve Force XXI (Figure 1). This plan is based on three complementary efforts. "Joint Venture," the main effort, is led by TRADOC. It is a process to redesign the force through a series of virtual, constructive, and live advanced warfighting experiments (AWEs). Re-engineering the division is the initial focus. A second effort of the plan, supervised by the Vice Chief of Staff of the Army, involves the reinvention of the Institutional Army. The third axis represents the development, acquisition, and fielding of information technologies. The Army Digitization Office leads this effort by ensuring that these technologies are horizontally integrated across the force.

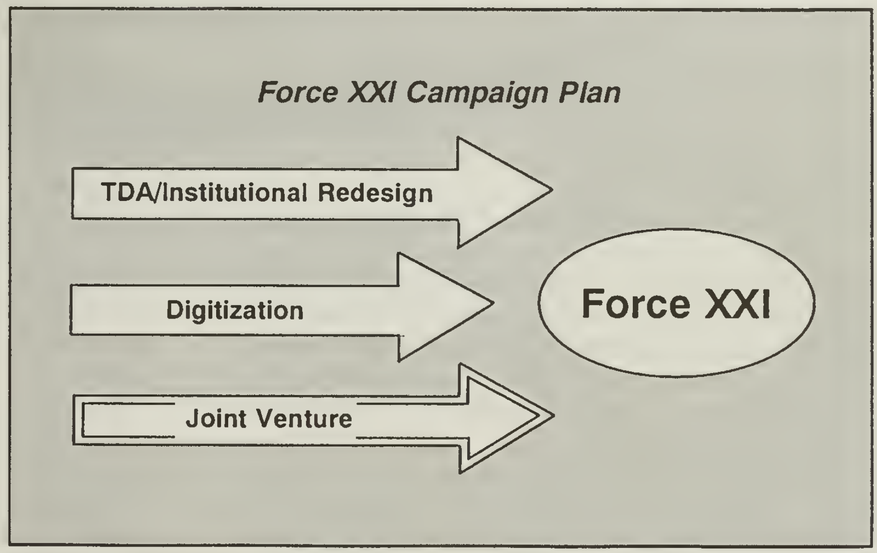

Figure 1

Participants throughout the Army are executing elements of the plan. For the engineer piece, the Engineer Center is developing a strategy to complement the Army's Force XXI Campaign Plan.

Engineer Force XXI Campaign Plan

The engineer force will evolve into the commandant's vision of a more versatile 2010 force. We must position ourselves in the year 2010 and gaze back to the present. First, create a vision, then throw a grappling hook to the present and pull ourselves forward. Our Engineer Force XXI Campaign Plan is the pathway to pull ourselves forward toward Force XXI engineers (Figure 2, page 4).

The commandant formed a task force to integrate engineer efforts across all doctrine, training, leader development, organizational, materiel, and

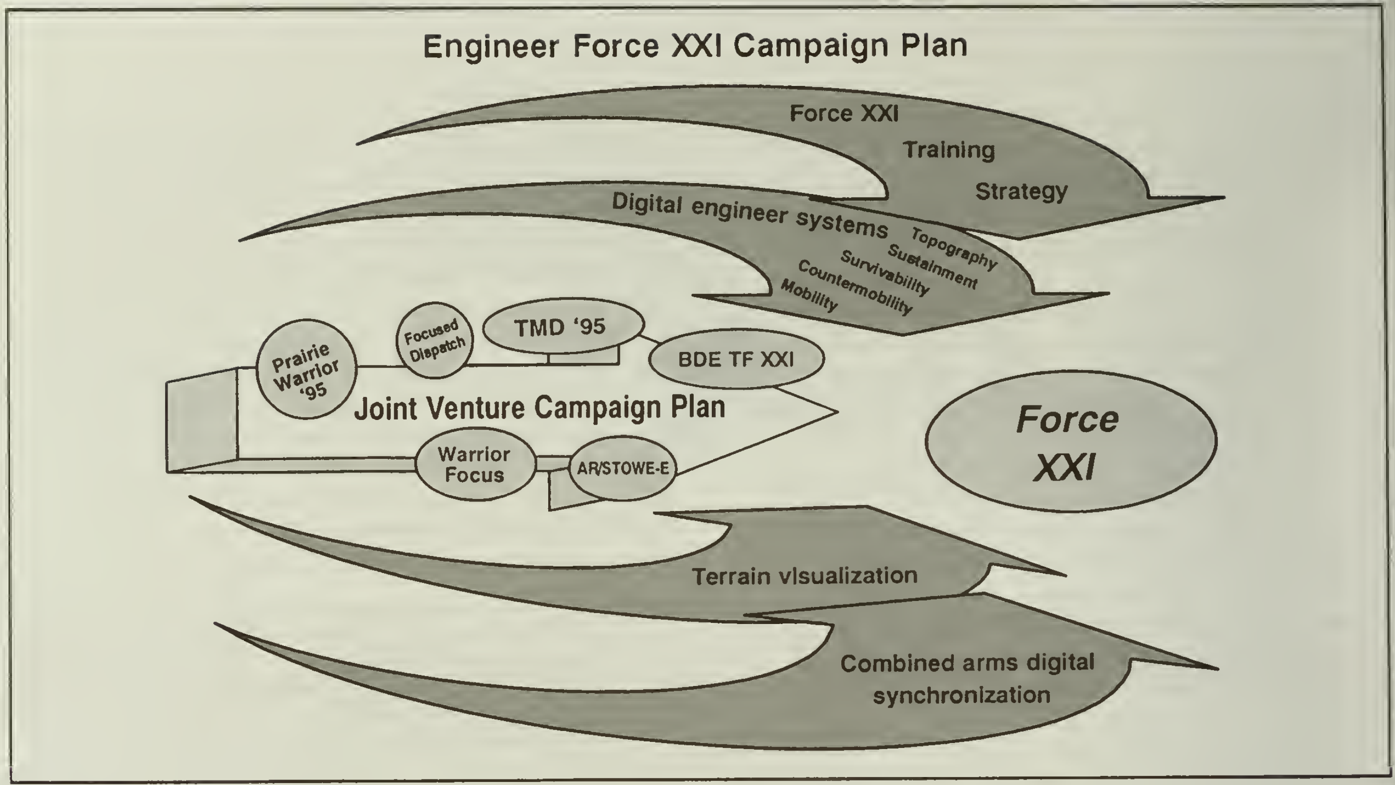

Figure 2. The Engineer School's plan has five axes to reach Force XXI.

soldier (DTLOMS). The task force developed the Engineer Force XXI Campaign Plan to synchronize Force XXI efforts. The plan's objective is Engineer Force XXI, a modernized and knowledge-based digitized engineer force capable of full and enhanced partnership with the Army's Force XXI.

Five complementary and interactive pathways lead to Engineer Force XXI. Each contains distinct characteristics, but all are interrelated and critical to the campaign's success. Our main effort is participation in TRADOC's Joint Venture Campaign. This effort will evolve organizational and operational capabilities for Force XXI engineers. Four supporting axes ensure total synchronization of the plan. Engineer digital synchronization integrates engineer command and control and information functional capabilities into the Army Battle Command Systems (ABCS) at all echelons. Training strategies being developed today ensure that our soldiers and leaders are prepared to fight the 2010 battle and succeed in operations other than war. Another major effort digitizes current and developing engineer systems. The fifth axis, terrain visualization, embeds terrain visualization capabilities throughout Force XXI and within ABCS. A discussion of each axis follows.

Joint Venture. The most important effort centers on redesigning the current total Army structure to produce the best possible force for tomorrow's Army. Joint Venture is a partnership between the Department of Army, TRADOC, and the other Major Army Commands (MACOMs); TRADOC Headquarters and the Battle Labs synchronize the effort. At the Engineer School, the Directorate of Combat Developments' Battle Lab Division is the school's lead element. The Battle Labs use the AWE process to test proposed operational and organizational strategies.

The primary purpose of the AWEs to provide insights into critical decisions the Engineer School and the Army must resolve. For example, we must determine how to equip, train, and develop doctrine and organizational structure for Force XXI. AWEs are sponsored by one of the TRADOC Battle Labs. They are culminating efforts focused on developing major increases to warfighting capabilities. AWEs impact across the TRADOC domains of DTLOMS and the battlefield operating systems (BOS). Additionally, advanced technology demonstrations and advanced concept technology demonstrations may feed technological assessments into the AWE process.

The Joint Venture Campaign Plan consists of three overlapping phases, as shown below. The centerpiece of the initial phase is the Task Force

Joint Venture Phases

1. Early experimentation to establish the initial baseline; it includes currently scheduled AWEs and ends with a final Division XXI design.
2. Force design, beginning with Task Force XXI (February 1997) and ending with Corps XXI.
3. Fielding and refinement, beginning with the Division XXI design and ending with the fielding of the first Applique-equipped corps in the year 2006.

XXI AWE, slated for February 1997. This AWE will utilize a brigade from the newly formed experimental force (EXFOR) from the 2d Armored Division; it will be digitally equipped and reorganized to leverage information-age technologies. Insights and lessons learned from this AWE will influence the interim design of the brigade and the division.

Unfortunately, the AWE comes too soon to leverage the modernization of the heavy engineer force with the Grizzly (Breacher) and the Wolverine (Heavy Assault Bridge). Other modernization initiatives, however, will be incorporated into the EXFOR: terrain visualization, ground robotics, Airborne Standoff Mine Detection System (ASTAMIDS), Ground Standoff Mine Detection System (GSTAMIDS), intelligent minefields, and the Assault Breach Marking System (ABMS).

A series of AWEs will build on each other and culminate in the Task Force XXI AWE. Prairie Warrior '95, hosted by the Battle Command Battle Lab, Fort Leavenworth, occurs in May 1995. Designed to leverage digital technology, it will help redesign the future division through simulation. One tool for doing this is the Mobile Strike Force portion of Prairie Warrior, where Command and General Staff College (CGSC) students equipped with 2010 technologies will organize and fight a 2010 battle using experimental force designs.

Prairie Warrior offers a great opportunity for engineers to demonstrate their added value to the battle as part of the combined arms team. Besides evaluating a myriad of new systems being integrated into the exercise, such as the Tactical Engineer Command and Control System (TECCS), the CGSC participants are evaluating experimental organizational structure.

The Mounted Battlespace Battle Lab will sponsor Focused Dispatch AWE in August 1995 at the Greenville Training Area, Kentucky. Focused Dispatch will evaluate an armored task force. Company C of the 19th Engineer Battalion has been designated as the engineer force. The hypothesis to be tested is that procedural, functional, and organizational changes in the different BOSs within the task force will result in enhancements to lethality, survivability, and tempo. Additionally, Focused Dispatch will evaluate digital connectivity requirements for battle command in brigade-and-below units.

Focused Dispatch has three phases: a constructive simulation, a virtual simulation, and a live exercise. Grizzly, Wolverine, and wide area munitions (WAM) will play in the constructive simulation. The intelligent minefield/WAM will play in the virtual simulation, as does ASTAMIDS. The live exercise will consist of WAM training munitions; the combat terrain information system with a terrain-visualization package; the assault breach marking system; and five Intervehicular Information System (IVIS) appliques for the engineer squad vehicles, platoon leader, and task-force engineer.

General Sullivan designated the Dismounted Battlespace Battle Lab's Warrior Focus AWE as the showcase experiment for 1995. Scheduled for November at the Joint Readiness Training Center, it will evaluate the organizational designs and tactics of a digitized and modernized light infantry task force. Key issues to be evaluated include en route battle command, own-the-night enhancements, survivability, joint digitization, SOF/conventional force interface, and battle command links from the brigade to the soldier. B Company, 41st Engineer Battalion, 10th Mountain Division, is designated as the engineer force in Warrior Focus. Engineer initiatives include enhancements in the countermine arena, a terrain visualization package, five digitized soldier systems, and night-vision enhancements.

In short, Joint Venture is an aggressive collection of AWEs on a tight time line. The AWEs represent an excellent opportunity to showcase and evaluate future engineer initiatives. Close ties between the Engineer School and tactical engineer units are necessary to ensure successful AWEs. But, what great training opportunities the AWEs provide for those units to field test and employ these new engineer initiatives!

Engineer Digital Synchronization. Engineers of 2010 will conduct knowledge-based operations with fully digitized command and control (C2) capabilities. They will be full partners in the Army's seamless C2 system called "Army Battle Command System" (Figure 3, page 6). The ABCS provides a single system C2 architecture. It integrates real-time situational information and sensor data into the force-level data base, with simultaneous display and near real-time access to the commander and the staff. The system provides the commander assured access to a relevant, seamless, and tailorable strategic-to-foxhole common picture.

The Engineer School is focusing most digital synchronization efforts toward integration into ABCS. Primary goals are to ensure that—

- Engineer digital C2 systems are inserted into the proper ABCS echelon.
- Appropriate engineer functions exist at all levels of ABCS.
- Engineer interests are fairly and correctly represented in all ABCS.

To achieve these goals, the Engineer School is focusing efforts at two levels. At the tactical level, the Army is pursuing a digitized C2 system called "Applique." It is a computer system that can be installed on platforms or vehicles to provide the maneuver force with the functions required to prepare

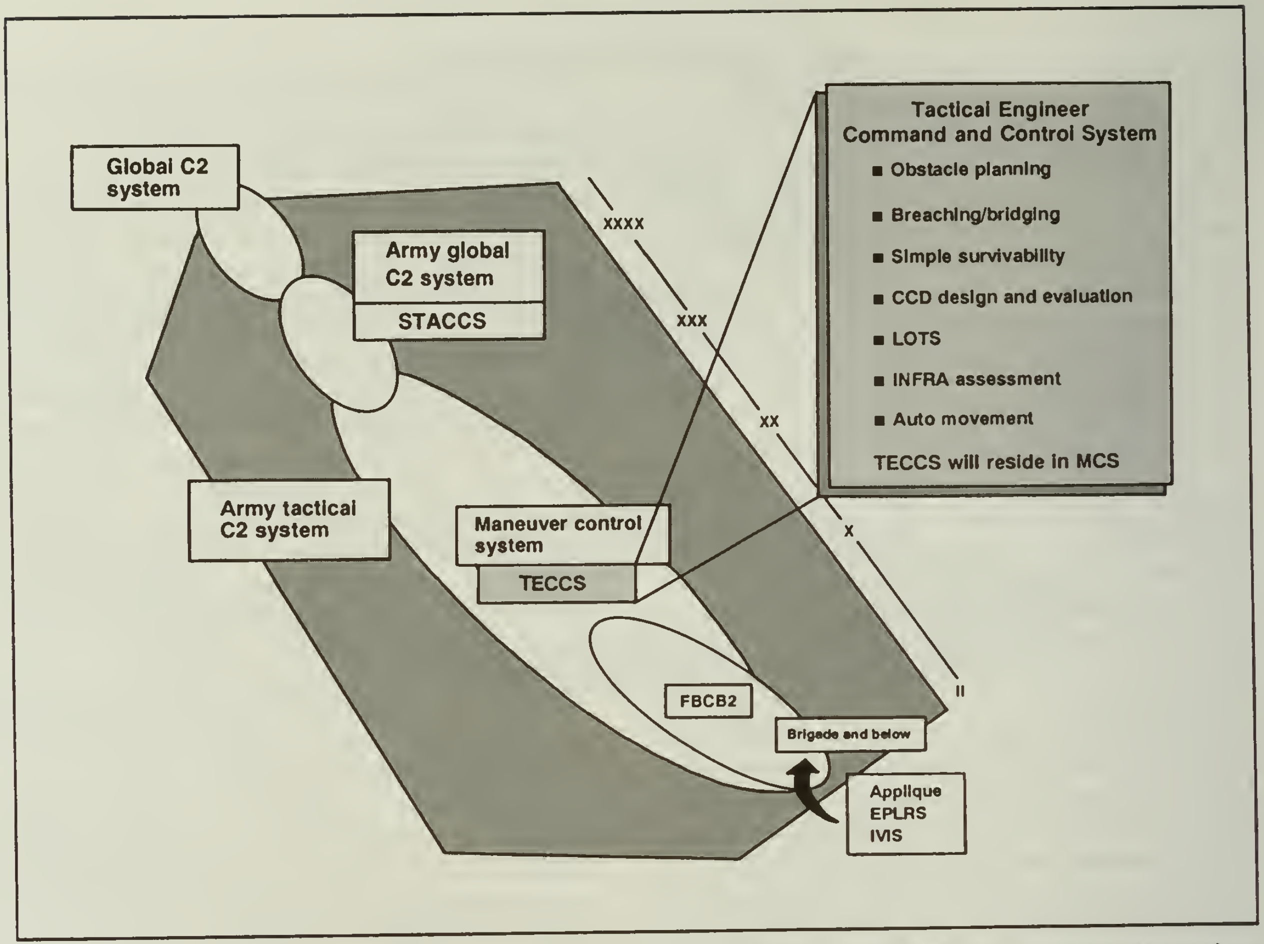

Figure 3. The Army's planned C2 architecture, from global systems (upper left) to the individual soldier and platform (lower right). TECCS and emerging engineer systems will be integrated within ABCS.

for and execute warfare and operations other than war. In general, Applique will be inserted at brigade and below levels. Components include a computer unit, a display, and input and auxiliary devices such as position/navigation tools. Applique systems support battle command and provide situational awareness, communications management, and battle command management. Task force elements will exchange orders and graphics, and maintain situational awareness in near real time. This equipment will be fielded to EXFOR engineers and the entire Task Force XXI at Fort Hood.

Forces within a digitally equipped task force currently use the IVIS to exchange digital information. The IVIS may be configured differently to meet specific user requirements. The C2 package provides basic situational awareness, mutual position/navigation, and plans and overlays. Additional packages add autonomous navigation and far-target identification. The current version of IVIS software allows countermobility planning, including obstacle overlays and five engineer reports. When integrated with the SINCGARS/digital radio system, IVIS provides commanders and staff the capability to pass and receive both digital and voice messages. It also allows for the horizontal and vertical exchange of critical battlefield C2 information, increased situational awareness, and the synchronization of other combat elements. M1A2 tanks are equipped with IVIS. The Engineer Center is pursuing ways to equip designated units, especially those participating in AWEs and early deploying contingency forces, with IVIS-like capability.

At brigade, division, and corps levels, engineer C2 will be integrated into the Maneuver Control System (MCS). It is one of a suite of automated C2 systems that make up the Army Tactical Command and Control System. MCS links commanders from corps through brigade and separate battalion levels. It gathers, synthesizes, presents and distributes information more effectively than manual methods. It reduces the time commanders need to acquire critical information and helps them make decisions and control mission execution. Within MCS, engineer-specific applications reside in the TECCS. It is a Windows-like automated system for mission planning that focuses on support to the warfighter. Several menu- or icon-driven mobility, countermobility, and survivability planning tools in TECCS automate many manual staff-planning tasks. They facilitate quick command decisions, leaving more time to execute engineer missions.

Some TECCS modules are complete. Trainers and developers at the Engineer Center are testing one module, called the Obstacle Planning System (OPS). This mission-planning system assists commanders and their operations staffs in planning the synergistic effects of obstacles with direct and indirect fires. It draws digital terrain data from the MCS data base to form a terrain-visualization "platform" for automated planning. Among its many capabilities, OPS graphically depicts terrain elements (including 3D representation), calculates and overlays mobility corridors, allows the user to design and graphically portray obstacle overlays, and allocates resources. The overlays may be printed in hard copy or be sent digitally to others within MCS.

Additional TECCS modules, such as bridging, survivability planning, and munitions effectiveness assessment tools, are in various stages of completion. The program manager for MCS will integrate TECCS into MCS during FY 96.

Training Strategy. The Engineer School has a clear and important mission to prepare our soldiers for the challenge of operating in Force XXI on the digitized battlefield. The commandant has provided his vision of attributes needed by engineer officers in the 21st century:

- Firm leadership foundation
- Solid base in doctrine
- Computer literacy
- Technological awareness
- Skill in information management
- Ability to synchronize multiple systems
- Versatility

The school has taken the first steps to fulfill expectations associated with that vision. Engineer officers and noncommissioned officers in the Department of Tactics and Leadership (DTL) are training soldiers assigned to combat divisions in the skills required to participate in AWEs. DTL has teamed up with the Joint Countermine Demonstrations Office, at Fort Belvoir, to train engineers in the 101st Airborne Division to use the Thermal Mine Avoidance System, which is a high-tech infrared camera. Engineers will use that system to support mine detection and main supply route clearance during an engineer-focused rotation at the Joint Readiness Training Center this year. The same trainers are writing tactics, techniques and procedures (TTPs) and participating in the train-up of engineers in the 10th Mountain Division for the AWE Warrior Focus. There, engineers will use digitized communications and several new engineer systems, including the close-in man-portable mine detector and the Antipersonnel Obstacle Breaching System. Additionally, engineers will use all of the new own-the-night equipment available for light forces, including improved night-vision equipment with third-generation imagers.

Concurrently, DTL is preparing TTP for the heavy engineer force. Exercise Focused Dispatch, scheduled for August 1995, will provide engineers in the 19th Engineer Battalion with the seamless connectivity of the IVIS. Engineers will test several of the experimental engineer systems mentioned earlier. Here, too, the Engineer School is providing experimental doctrine and participating in training soldiers.

While participating in the train-up and the AWEs, instructors and writers will quickly capture lessons learned and inject them into doctrine and the lesson plans used to train officers, NCOs, and

The Operations NCO of Company C, 317th Engineer Battalion, uses a situational awareness terminal of the Enhanced Position Location Reporting System (EPLRS) to track the company's movement.

soldiers. They will promulgate some "initial thoughts" through fact sheets and post after-action reports to the Engineer School Bulletin Board; ultimately the lessons will proceed through the Center for Army Lessons Learned (CALL) system and end up in official lessons learned for the entire Army.

Officers and NCOs in DTL also are working with the computerized Obstacle Planning System developed by the Waterways Experimentation Station. They are participating in the development of the Combat Arms Tactical Trainer and a standard electronic reporting system for the Army. Their efforts ensure that future digital engineer systems are fully interoperable, that developmental systems are addressed in doctrine, and that the systems are user friendly. Our training developers will quickly incorporate the required skills, knowledges, and abilities into the programs of instruction for engineers.

In the area of training development, the entire school, led by the Directorate of Training (DOT), is preparing for Force XXI. DTL is coordinating school input to the Force XXI training program being developed by the Armor School, at Fort Knox. DOT personnel are working closely with the Simulation, Training and Instrumentation Command to develop an engineer training system that can be used to simulate the Grizzly, the Wolverine, and other systems. Most importantly, the DOT is systematically reviewing the program of instruction for officer training. As a result of that review, a redesigned program of instruction for FY 96 will capture the commandant's guidance for Force XXI engineers.

The Engineer School is actively involved in developing and testing new systems. Instructors/writers are providing training and TTPs to make the systems work. They are capturing lessons learned and analyzing the results. In short, the DOT is developing forward-looking doctrine and training and is participating in the development of organizations and systems to equip engineer leaders and soldiers for the 21st century.

Digital Engineer Systems. Many digital technologies with potential combat engineer applications either exist today or are evolving. Combat developers at the Engineer Center are examining promising digital system concepts with the Battle Labs, other branch proponents, and private industry. These technologies span operational applications from the close fight to theater-level engineering.

Emerging systems with embedded digital technologies will provide close combat engineers with enhanced information-based capability to ensure full partnership on the 2010 battlefield. For example, both the Grizzly and the Wolverine have embedded IVIS-like equipment, including GPS, a monitor, and a computer. Grizzly and Wolverine crews will share situational awareness with other task force elements; their capabilities will enhance battlefield synchronization. When conducting a breach, task force commanders will have complete confidence both in the Grizzly's minefield-breaching capability and in the crews' ability to navigate precisely to the right breach site.

The Engineer School is exploring other digital system ideas. For example, the intelligent minefield system promises to transform obstacle doctrine. It centers around smart munitions, such as WAM, coupled to a C2 gateway. WAM is capable of indirect firing, discriminates between targets, and seeks and destroys prioritized targets autonomously. The gateway is emplaced near the WAM and can exercise control of as many as 12 munitions. When a GPS transceiver is integrated into the gateway, it becomes an autonomous sentry that can take reports of enemy activities from subordinate WAMs. The gateway is, in effect, the squad leader of a cluster of munitions.

Another system under study is the Terrain Reconnaissance Tool (TRT). A GPS-based, geographic data-collection system, its primary function is to quickly capture data that support other geographic information systems. Collected data are relayed digitally to terrain teams to update maps. Intelligent minefields and TRT are just two examples of technology that will help engineers perform their missions faster and more efficiently.

In the rear battle, digital engineer systems allow faster and more efficient planning and execution. The Theater Construction Management System is one such tool. Already in use by higher level engineer commands, such as engineer brigades and groups, it automates the theater construction design process. The system has both custom and commercial software packages, including project management, CAD, data-base management, and an underlying Army Functional Component System (AFCS) data base. A 1995 version operates as a Windows system. While using units must purchase their own computers, units on the fielding distribution plan will receive a 230Mb Bernoulli external hard drive unit, AUTOCAD LT, Microsoft Project 4, and Close-Up 6, as well as customized software and an AFCS data base.

Combat heavy engineers will rely more on automation, laser technologies, and location/navigation systems to execute their missions. Laser-grade control devices, sensors, GPS, digital transmitters/receivers, and display screens will be installed in construction equipment. These technologies will simplify earthmoving tasks, mission planning, and project management.

Terrain Visualization. As the TRADOC proponent for terrain visualization, the Engineer

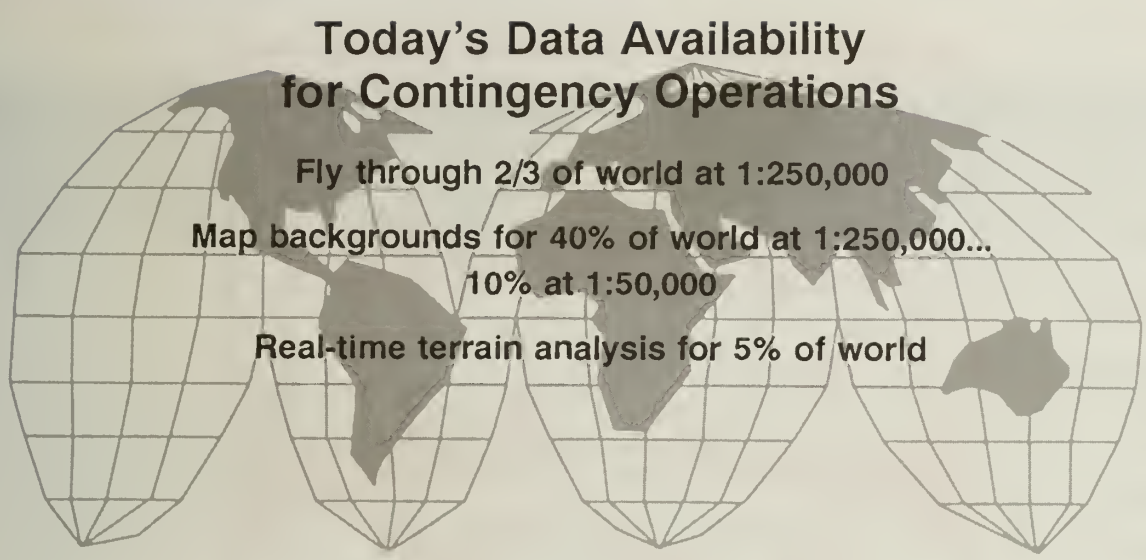
Today's Data Availability for Contingency Operations
Fly through 2/3 of world at 1:250,000
Map backgrounds for 40% of world at 1:250,000...
10% at 1:50,000
Real-time terrain analysis for 5% of world

Figure 4

Center is responsible for ensuring that terrain-visualization requirements are identified, developed, and integrated throughout the Force XXI Campaign Plan.

Terrain visualization, which portrays natural and cultural features within an area of interest, is the engineers' responsibility. While important, terrain visualization alone does not meet all of a commander's needs. He also needs battlefield visualization, which adds operational graphics (overlaid information) to terrain visualization to provide situational awareness. Commanders have indicated they want maps, map backgrounds, a fly-through capability, real-time analysis of the terrain, a playing field for mission planning and rehearsal systems, and models and simulations. The models and simulations should use the same data base as the operational systems. Commanders want all systems tied together to give their forces a common picture of the battlefield. The ABCS will use the Terrain Evaluation Module to provide both the map background for command and control plus the capability to develop 10 tactical decision aids. While that sounds good, the current lack of available digital data worldwide (see Figure 4) may affect mission planning and execution in the near future.

The commandant sees three challenges for terrain visualization: consistent requirements, data availability/collection, and data dissemination. Through Force XXI initiatives, engineers have identified opportunities to work in specific efforts to address these challenges. Much of the work entails refining what commanders need for battlefield visualization to allow better situational awareness.

With the shift to contingency-based operations, the Army has re-evaluated existing capabilities. We now must develop and provide additional tools for planning, command and control, modeling and simulation, and training systems. Commanders and staffs require these systems to distribute up-to-date digital terrain data.

The recent crises in Rwanda and Haiti demonstrated the need for a better and more responsive capability to provide updated map products and digital terrain data. The need is two-fold: Commanders require rapidly produced paper maps as well as digital terrain data to use as map backgrounds. The latter reside in future C2 systems and simulations. The simulations provide rapid training and rehearsal tools for force training exercises prior to deployment.

The Engineer School's Terrain Visualization Center is working with other agencies to meet these challenges. For example, the school hosted a series of meetings in the summer of 1994 with the Battle Labs, the proponent schools, and the MACOMs to identify and define digital terrain data requirements for operational forces. The participants formed a team to incorporate information derived from those meetings into a terrain visualization master plan. It addresses the commandant's terrain-visualization challenges and provides a road map for terrain-visualization initiatives. The Engineer School will integrate efforts such as these with those of other agencies for evaluation in an AWE.

The AWEs in which initiatives will be inserted to test and improve battlefield visualization for the commander are shown on the table, page 10. These tests and the resulting lessons learned are critical in developing Force XXI requirements. Engineers are leading the Army in articulating and meeting Force XXI terrain-visualization requirements. This must be an Armywide coordinated effort. Lacking a coordinated effort, commanders will seek costly and inefficient nonstandard solutions to their needs. Therefore, a major mission of the Terrain Visualization Center is to ensure that data-collection and dissemination efforts are integrated throughout Force XXI.

Terrain Visualization Insertions

	Capabilities	USACOM Exercise	Prairie Warrior	Focused Dispatch	Warrior Focus	Brigade TF XXI	Division XXI	Corps XXI
Battlefield Visualization	Split-Based Operations	X		X	X	X		X
	Situational Awareness		X		X			
	MPRS				X			
	Terrain Analysis			X			X	
	BCDSS	X	X					
	3-Dimensional Fly Through				X			

The Road Ahead

By way of five pathways, we have embarked on the road toward Force XXI engineers. Most of the journey lies ahead. The entire engineer community must work with the combined arms team as we proceed through Joint Venture AWEs. Our supporting efforts (combined arms digital synchronization, training strategies, digital engineer systems, and terrain visualization) are essential to the success of this campaign. Each effort requires extensive resources. Understanding that resources are limited, we must organize around purpose, not physical limitations. Our purpose is to persist as joint partners in moving beyond what we have stylized as the American way of conducting ground warfare (maneuver warfare) toward control warfare. To do that we must employ the synergistic power of integrated information and communications.

This journey will have extensive implications throughout DTLOMS. Engineer doctrine will incorporate the effects of digitization and the TTP that flow from the application of digitized processes. Training engineer soldiers and leaders to become reflexively comfortable and highly competent in digitized procedures will be the single largest challenge. The conversion of "doing engineer business" by voice and paper reports to a digitized, integrated information system that works primarily through a computer screen must be seamless. While we expect a lot of tinkering and fine tuning of engineer organizations, we believe that the basic engineer structure of the heavy division will not undergo dramatic change. The engineer force must receive comparable, concurrent, and compatible fieldings of common digitized command and control suites. Our desired end state is fully digitized equipment Armywide. Fiscal constraints, however, will impede the transformation of the total Army force and our combined partners from an analog mode to a digital mode well into the 21st century. Most importantly, we must keep faith with our soldiers and give them the most effective doctrine, training, leaders, and materiel that America can produce.

The revolution has barely begun. Where the industrial revolution harnessed energy and machines to enhance muscle power, the information revolution will harness communications, sensors, and computers to enhance brain power. This is the power of Force XXI engineers.

Reference

[1] Office of the Chief of Staff, Army, "Force XXI...America's Army of the 21st Century," 15 January 1995, page 1.

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Lieutenant Colonel Scott Fernald, Chief, Engineer Support Battle Lab, Directorate of Combat Developments.

Lieutenant Colonel Joseph Kotch, Jr., Chief, Topographic Engineering, Directorate of Combat Developments.

Lieutenant Colonel Joseph Wetherell, Director of Tactics and Leadership, Directorate of Training.

ENFORCE XXI

By The ENFORCE XXI Task Force Team

Essayons! The word has never meant more than it does today. The U.S. Army engineer force is rapidly entering one of the most dynamic periods of its existence, in terms of doctrine, training, leader development, organization, materiel, and soldiers (DTLOMS). As the Army faces the challenges of a changing strategic and geopolitical environment, engineers will play an instrumental role in war and operations other than war (OOTW). Modernizing the engineer force by leveraging technology is the key to providing better support to the maneuver forces' control of battle space. This is essential under our national military strategy, which emphasizes winning decisively, swiftly, and with minimal expenditure of national resources. This is the new standard. We have demonstrated that we can fight at a level that quickly overwhelms our opponents.

Force XXI will be the world's preeminent joint land fighting force, and the way it fights will determine the nature of postindustrial warfare. Engineers will be at the vanguard of this movement. The Force XXI concept, the Army of the 21st century, is defined by five characteristics:

- Doctrinal flexibility
- Strategic mobility
- Tailorability and modularity
- Joint and multinational connectivity
- Versatility to function in war and OOTW

The 1995 ENFORCE XXI conference at Fort Leonard Wood reinforces to our senior leaders that the engineer force has its azimuth set correctly and embodies these characteristics. ENFORCE XXI describes a vision showing how engineers will meet the challenges of the 21st century.

To ensure that engineers maintain an integral role in the combined arms Army of the future, the U.S. Army Engineer Center's vision remains focused on two areas—doctrine and modernization. To ensure victory over any land force, engineers must use modernization overmatch to dominate maneuver, win the information war, and protect the force on a multidimensional battlefield. Force modernization initiatives now being fielded, and others on the near horizon, will ensure that engineer forces are key players.

In a radical departure from previous conferences, ENFORCE XXI features demonstrations and displays that allow senior leaders to witness the lethality, survivability, and functionality of our new equipment, using four operational environments:

- Early-entry/lodgment
- Heavy/light
- Own the water
- Mounted/battle command

Early-Entry/Lodgement Operations

The ability to rapidly mobilize, deploy anywhere in the world, and execute missions ranging from nation assistance to large-scale combat operations means that our early-entry forces must be versatile as well as lethal and survivable. With the emphasis on versatility, any tailorable early-entry force will probably include engineers. In most OOTW missions, engineers will remain the units of choice. To continue to meet this demand, the supporting engineer force must expand its versatility, while growing lighter and reaching deeper, without sacrificing lethality and survivability. We must cultivate third-wave technology to achieve this end state.

ENFORCE XXI demonstrations show that engineers will remain vital to early-entry operations. The conference presents more than 20 new and developmental pieces of engineer equipment designed to improve and enhance reconnaissance operations, airfield seizure and cordonment (countermobility), airfield clearance (mobility), and the infrastructure enhancement (sustainment).

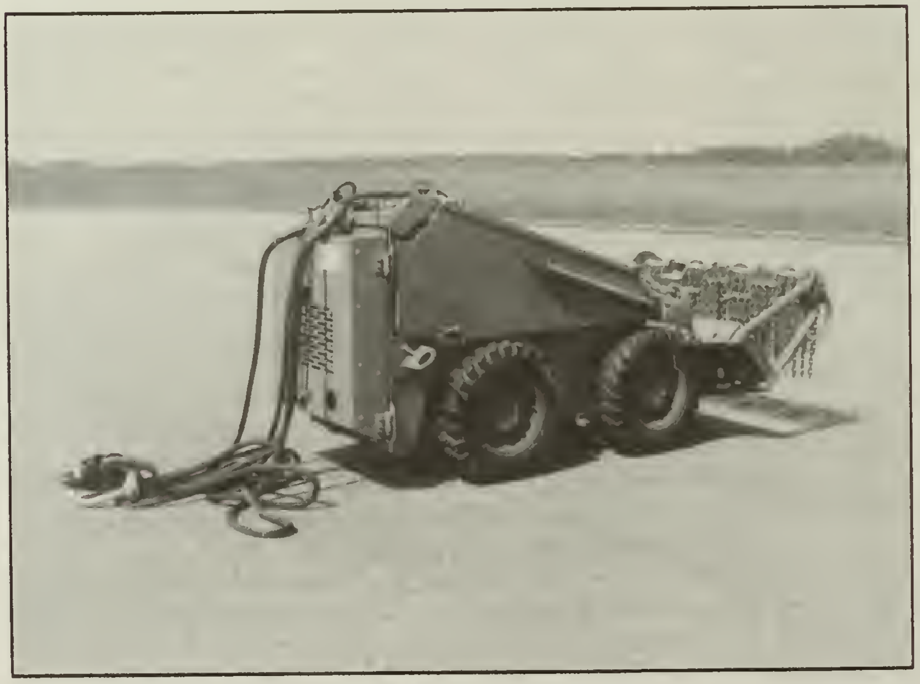
The engineer mission, reduced to its essential nature, remains one of terrain exploitation. Using and enhancing the terrain's advantages and disadvantages defines the engineer's charge. Engineers transform terrain by making it mobile, protective, and liveable to friendly forces, while enhancing its lethality to the enemy. To do that requires information about the environment—engineer intelligence. Advancements in technology have greatly enhanced the engineer's ability to collect accurate, real-time terrain data and will potentially alter the engineer's role in combined arms reconnaissance.

During the early-entry demonstration, two remotely controlled vehicles with video cameras and digitized collection software transmit live footage and data back to planners. Additionally, two handheld systems—the terrain reconnaissance tool (TRT) and the Vector map—give engineers the ability to lase and digitally record significant terrain information with Global Positioning System (GPS) accuracy. This data-collection capability transforms intelligence gathering and enhances the engineer force as a combat multiplier.

Early-entry operations are often initiated with airborne operations. For clearing flight landing strips (FLS), engineers will have new equipment to find and remove mines or unexploded ordnance (UXO) and to repair any damage. New mine-detection equipment, such as the remote HMMWV and infrared camera (Infracam)/close-in, man-portable mine detector (CIMMD), allows engineers to locate mines and UXO faster, with fewer false detections and far less risk to soldiers. Operators will wear new countermine protective gear for additional survivability.

Instead of detonating UXO in-place, which would damage the FLS, robots will move the UXO to a disposal site. A remote excavator will move larger UXO, such as unexploded bombs, and a remote-controlled robot called the mini-flail will sweep mines off the FLS. Engineer paratroopers will have new earth-moving, transport, and compaction equipment to repair bomb craters and open the FLS to traffic.

Another phase of early-entry/lodgement operations is infrastructure enhancement. Within the last five years, engineers have repeatedly demonstrated their vital role in repairing and improving a nation's infrastructure. Sustainment engineering capabilities will improve with new construction equipment now being fielded: a GPS dozer, a laser-plane grader, an improved K-Span building, Unimat, an improved theater construction management system van, and improved soil binders.



A mini-flail rigged for helicopter flight testing.

Heavy/Light Operations

The heavy/light ENFORCE XXI demonstration showcases some warfighting systems and capabilities that engineers of the 21st century will have for military operations on urbanized terrain (MOUT). These systems will provide key enhancements to mounted and dismounted warfighting in terms of survivability, mobility, situational awareness, battle command, and operational tempo.

Before an actual deployment, a task force staff can train inexpensively using realistic computer simulations. One such simulation is JANUS, an interactive, two-sided computer simulation that allows opposing forces to simultaneously execute their missions and respond with countermaneuvers. JANUS permits a task force commander and his staff to synchronize the battlefield operating systems and test the tactics, techniques, and procedures they would employ during a mission. The battlefield or area of operations is accurately depicted on the computer screen, including all terrain features, roads, and contour lines. A recent addition to the JANUS software accurately simulates built-up areas and urban fighting, which provides a commander and his staff alternatives to costly full-scale exercises.

Photo courtesy HJ Ford & Associates

UAV Pointer provides real-time video feed en route to the objective to confirm or deny enemy positions. It allows the commander to maneuver his forces as required.

The unmanned aerial vehicle (UAV) Pointer, a remote-controlled reconnaissance tool similar to a large model airplane, provides a video feed to a commander on the ground and lets him see an area he may soon encounter. This en-route intelligence provides real-time, crucial information about an objective or axis of advance without warning the enemy of an impending attack. The UAV Pointer and the Airborne Standoff Minefield Detection System (ASTAMIDS) can also identify actual minefield locations, enabling a commander to confirm or deny templated enemy positions and obstacle locations and to change his plan if necessary.

Once the support force obscures the enemy's air defense weapons, the preferred technique for entering a MOUT environment is a vertical insertion. Sappers and infantrymen rappel onto rooftops and, using demolitions to create openings, enter the buildings from above. A newly developed kevlar blanket placed over the charge enables soldiers to remain close to the charge and rush into the room below immediately after the explosion.

The Ferret, an unmanned MOUT mine-clearing/UXO-clearing vehicle, will eliminate risks associated with a detailed room-to-room clearing. It will decrease the need to send soldiers into unfamiliar buildings that may be booby-trapped. Once inside a building, the robot provides real-time video feeds to an operator positioned safely outside. The robot detects thermal signatures associated with the presence of mines or explosive charges and conducts reconnaissance for mines and booby traps, subsequently marking or neutralizing them. Personnel at Fort Leonard Wood have also successfully tested the Ferret in clearing an underground tunnel.

Engineers will have several new breaching aids to assist follow-on vehicles entering towns. The Antipersonnel Obstacle-Breaching System (APOBS), which is a man-portable line charge, and the extended range grapnel (ERG) are two emerging technologies that will enhance the breaching fundamental of reduction. The previously mentioned mini-flail is a breaching asset that detonates or destroys all known antipersonnel mines, buried or surface-laid. It creates a lane quickly and improves engineer survivability on the battlefield.

The Panther, an obstacle breacher, and the Badger, a mine detector, are examples of robotics technology that the Engineer School's engineer vehicle teleoperation (EVT) program is developing. A major requirement of robotics technology is that it must not interfere with the host vehicle's normal, manned operation. A second requirement is that, when operated in the unmanned mode, the robotics technology must allow a remote operator to perform vehicle functions compatible with manned operation.

Designed specifically for an OOTW environment, the Panther is a remote-controlled "battering ram" that effectively reduces roadblocks. This unmanned M-60 chassis with a rubble-clearing blade is an unobtrusive obstacle-breaching vehicle that the local populace will not view as threatening. In an armed conflict, however, the unmanned CEV can accomplish the same mission while also providing offensive capabilities.

Behind the front-line engineers will come the Badger, an unmanned, ground-vehicle, mine-detection system that operates on a 900-series, 5-ton chassis or on a HMMWV. It will detect mines and mark and proof lanes while carrying a mine-neutralization team. This recent generation of the Thermal Mine-Avoidance System (TMAS) was successfully tested in Operation Restore Hope and effectively detects buried mines along main supply routes. The system greatly enhances the speed, accuracy, and survivability with which sappers clear a route or proof a lane through a minefield. Stand-off mine-detection capabilities will bring engineer countermine operations into synch with the Age of Technology.

Sappers will soon travel in relative luxury in the mobile tactical light vehicle (MTLV), the "stretch" M113A3. It carries a complete squad with all its equipment, eliminating the need for a trailer. The armored vehicle-launched bridge (AVLB) super sport, an interim fix before fielding the heavy assault bridge (HAB), provides engineers a mobility asset that keeps pace with Force XXI units.

The explosive formed penetrator (EFP), which is a disc-shaped, tripod-mounted, projectile explosive charge that penetrates reinforced concrete, is an ideal weapon for destroying bridge piers and abutments. The shoulder-fired bunker defeat munition (BDM) can blow an initial hole in reinforced concrete for entering buildings. It can also blow adjacent walls to create covered mobility routes through built-up areas for dismounted soldiers.

The newest mine in the Army's arsenal is the selectable, lightweight attack munition (SLAM). It is a hand-emplaced, antimateriel, antivehicle munition that is compact, effective, and readily usable by strategic offensive forces and sappers. SLAM's EFP warhead, which can penetrate 40 millimeters of homogeneous steel, has four methods of detonation: pressure, tension-release, command, or time delay.

Recent experiences in Kafji and Kuwait City indicate that the CEV is still the vehicle of choice for engineers in a MOUT environment. A survivable breaching asset, the CEV effectively reduces barrier obstacles, fortifications, and strongpoints. With changes to existing hydraulics and electrical systems improving its performance tremendously, the CEV will continue to be an effective combat multiplier into the 21st century.

Own-the-Water Operations

Technological developments will significantly impact our approach to river-crossing operations in the next century. As the Army's mobility experts, engineers must quickly negotiate water obstacles and cross a maneuver force. Modern technology will increase the likelihood of success during all phases of a river-crossing operation.

The Army's ability to exploit enhanced night-vision technology is critical to successful river-crossing operations. Modern technological advances being exploited at the Dismounted Battlespace Battle Laboratory and the Night Vision Laboratory are bringing several night-vision devices to Army units. High-intensity, infrared light-emitting devices, such as Black Lights and Phoenix infrared markers, will greatly assist engineers and crossing forces on both near and far shores. These devices can either provide infrared illumination in such areas as engineer regulating points or be employed as markers to facilitate command and control at crossing sites.

Advances in night-vision technology are included in the equipment of the 21st century "land warrior." Its thermal capability gives soldiers the ability to see and engage targets out to the maximum effective range of their weapons system. Additionally, aerial vehicles equipped with an infrared standoff mine-detection capability will significantly increase our ability to detect threat minefields along water obstacles before troops cross them.

Advanced technology is also improving engineer reconnaissance efforts and river-crossing planning. Nonstandard terrain-visualization products, such as satellite multispectral imagery, will help engineers with intelligence preparation of the battlefield (IPB)/engineer battlefield assessment (EBA) products and the final crossing overlay. The Integrated Meteorological System (IMETS) further enhances the planning process by analyzing the effects of weather conditions. The engineer light diving team (ELDT), assigned at the corps level, will be task organized to the crossing support forces. The team will provide detailed reconnaissance information about river and bank conditions at potential crossing sites, as well as information about obstacles and threat forces along the exit bank. The UAV Pointer, mounted with either a daylight or a night-vision camera, facilitates 24-hour real-time intelligence collection. This timely intelligence allows the maneuver commander to verify the threat situation and establish force-oriented objectives within the bridgehead.

During the advance-to-the-river phase of a river-crossing operation, the ELDT will mark the far shore

A HEMTT-based improved common bridge transporter from a corps multirole bridge company recovers a ribbon bridge bay.

using infrared markers and destroy underwater obstacles using demolitions primed with the modernized demolitions initiator (MDI). The ELDT will maintain constant communications with the crossing-force engineer using a dual underwater-land communications system.

The assaulting forces will cross the river using advanced systems. The first wave will use jet skis, which are fast and highly maneuverable, to provide immediate local security and suppress enemy small-arms fire before the remaining assault forces cross the river. The second assault wave will cross in Zodiac assault boats powered by the Improved Marine Amphibious Reconnaissance System (IMARS). To protect the assault force, the Advanced Precision Aerial Delivery System (APADS), a steerable parachute system controlled either remotely or with preprogrammed flight paths in its integral GPS, can deploy wide-area mines (WAM) to prevent threat direct-fire systems from repositioning along the far shore.

After securing the exit bank objectives, rafting will begin with the HEMTT-based improved common bridge transporter (ICBT) launching ribbon bays into the water. The ICBT employs the Palletized Loading System (PLS), which can carry either cargo or a ribbon bay. To speed up preparation of the exit bank, one of the first vehicles across will be the Deuce, a rubber-tracked dozer. It gives crossing force engineers a mobile and effective earth-moving asset that has more speed and flexibility than steel-tracked dozer equipment. Both the ICBT and the Deuce are integral to the engineer multirole bridge company (MRBC), which is organized to provide crossing support to Force XXI.

Mounted/Battle Command Operations

The ENFORCE XXI Battle Command demonstration highlights the combined arms digital battlefield and its impact on engineer operations. The battlefields of the 21st century will be characterized by real-time data, improved command and control, and the enhanced lethality, tempo, and survivability of the mounted combined arms force.

A digitized combined arms force will plan, prepare, and execute combat operations by employing third-wave technology and newly developed battlefield systems. Emerging technologies will improve lethality, survivability, and tempo in five key areas:

- Better, faster access to intelligence data
- Improved situational awareness/combat identification
- Enhanced battle command
- Improved synchronization of direct and indirect fires
- Improved force protection

For example, the Intervehicular Information System (IVIS) is a

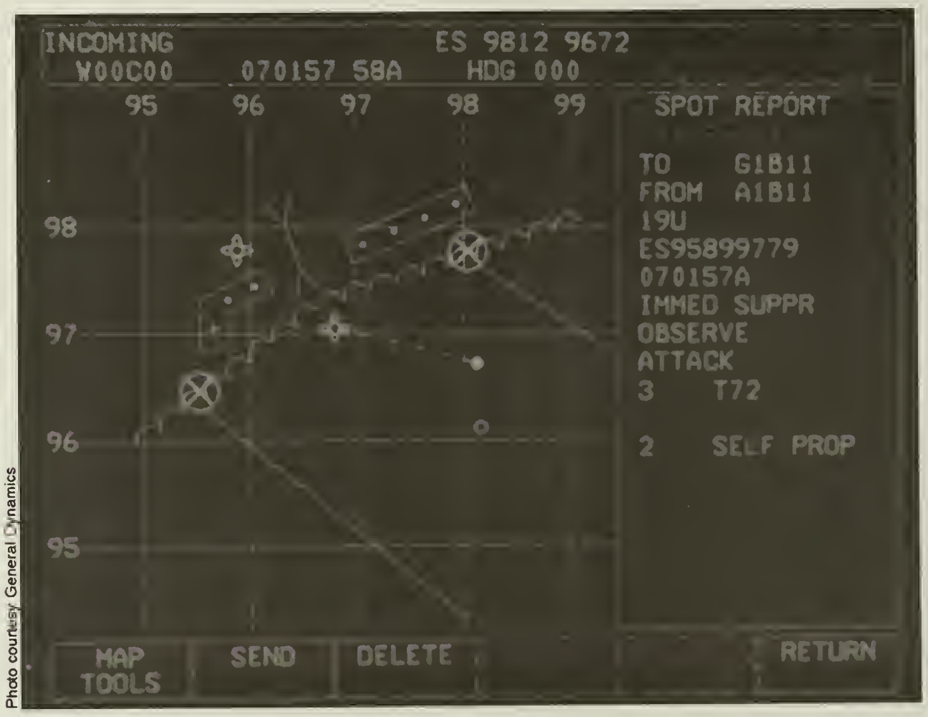


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Photo courtesy General Dynamics

An IVIS display screen

digital system that assists commanders in making timely and appropriate decisions. IVIS may become the chosen digital system used in all types of combat, combat support, and combat service support vehicles. Commanders can use this tool to better visualize the battlefield and execute a synchronized plan. With the IVIS screen, a commander can track the positioning of his forces in relation to the terrain and the enemy and can maneuver to mass and fight at the decisive place and time.

IVIS will also improve the engineers' ability to conduct combined arms breaching operations. At the National Training Center, friendly forces frequently struggle to achieve a synchronized breaching operation, which is a tenet of breaching that must be met to be successful. IVIS will assist key elements in a brigade or task force as they maneuver and apply their battlefield function at the critical time. IVIS will assist the commander and other key players in executing a synchronized breach plan. Situation awareness is critical to developing synergy on the battlefield. IVIS can help create conditions that will allow a brigade's total combat power to mass at the breach and the point of penetration.

Timely and accurate information is power. Future commanders must assimilate battlefield information and make tactical decisions using advanced technology. Engineer commanders in mounted warfare must understand digitization and how to integrate and synchronize engineer operations on a digital battlefield.

Looking Ahead

ENFORCE XXI provides a new concept and a new design for the engineer force to help it meet the needs of a volatile and ever-changing world. The concept is centered around quality soldiers and leaders whose full potential is more closely realized through information-age technologies and rigorous and relevant training and leader development. These technological advances demand a 21st century soldier equal to the sophisticated systems of the future. Soldiers will remain the most important element of the force, for it is through quality soldiers that the full power of technology will be realized.

The engineers of the 21st century will be prepared to face the full spectrum of operational environments. They will design organizations and develop capabilities to allow the force to rapidly tailor and expand, strategically deploy, and effectively employ as part of a combined arms, joint and multinational team that achieves decisive results in future wars and OOTW.

The bottom line is that engineers will lead the way in equipment modernization needed to survive on increasingly lethal and fluid battlefields. Our smaller, more lethal, and more flexible force will ensure that its training contributes to the wide variety of missions in which it might be employed. The total engineer force must remain doctrinally sound and materially ready. Engineer challenges of the future are to continue to know the doctrine, make terrain an asset and a weapon, embrace and exploit new technology, and remain an integral part of the combined arms team.

The ENFORCE XXI Task Force Team are all members of the Directorate of Training within the U.S. Army Engineer School. This combined arms team is comprised of:

LTC Jim Burns, ENFORCE XXI coordinator.

MAJ Rene Belanger, Senior Team Leader for EOAC.

MAJ Erik Carey, Canadian Exchange Officer and Senior Team Leader for EOAC.

MAJ George DeMarse, Chief of Doctrine Branch.

MAJ Kevin Woods, Senior Team Leader for EOAC.

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Additional support for this article provided by CPT Dion Bates.

Joint Forces Engineer Command: A Proposal

By Colonel Jerry L. Anderson and Colonel James H. Robinson

Joint is here. Army engineers are training as carpenters, builders, and steelworkers at Gulfport, Mississippi, and mechanics will train at Port Hueneme, California. Starting in October 1995, Navy Seabees and Air Force engineers will train on Army heavy engineer equipment at Fort Leonard Wood, Missouri. Training for plumbers and electricians soon will be conducted at Sheppard Air Force Base, Texas.

Issues. Jointness seems simple on the surface, but the jargon and terminology used by the various services are not easily discernible and sometimes defy logic. In the December 1994 issue of *ENGINEER*, Major General Ballard [1] discussed a host of minor differences in terms of training, equipment, organizations, and doctrine between services. Engineers must be especially clear about operational-level engineer missions, joint and multinational operations, and notional force designs. Rear Admiral Jack E. Buffington[2] notes an increasingly crucial need for engineer officers to gain greater exposure to the engineers of other services. He recommends more officer billet exchanges and seminars at engineer officer courses. Following the suggestions of the Roles and Mission Study, Colonel Lee Gibson[3] strongly endorsed the idea of establishing joint engineer working groups. These working groups are to investigate potential areas of benefit in engineer acquisition, doctrine, force structure, training, and operation programs. Questions like "Why can't the joint services consolidate the research, development, and acquisition of engineer construction and combat equipment?" and "Why can't joint service engineers use the same construction standards and even the same construction management and component systems?" are asked.

Efforts to improve efficiency and to avoid duplication of effort are not confined to uniformed members of the Department of Defense (DOD). The research and development community initiated Project Reliance to provide areas of primary focus for research development testing and engineering across DOD, with areas of responsibility for research identified for each service component.

Rationale. Recent deployments of engineers were fully joint operations, not necessarily from a well-designed plan, but through necessity. That does not mean that those who were responsible for responding to an immediate situation were negligent or irresponsible; it means that their plan and the execution of that plan were based on individual dynamism and leadership not on joint doctrine. Navy Captain John Lehman[4] states that since Desert Storm, the U.S. military has operated as a joint force in nearly every significant operation—whether it was a regional contingency operation or a humanitarian-relief, a disaster-recovery, or a nation-assistance scenario. Rear Admiral Jack E.

Buffington[5] further adds that unified operations fundamentally shape the way we think about and train for war. The need for understanding each service's mission and capabilities requires development of doctrine to support effective joint operations.

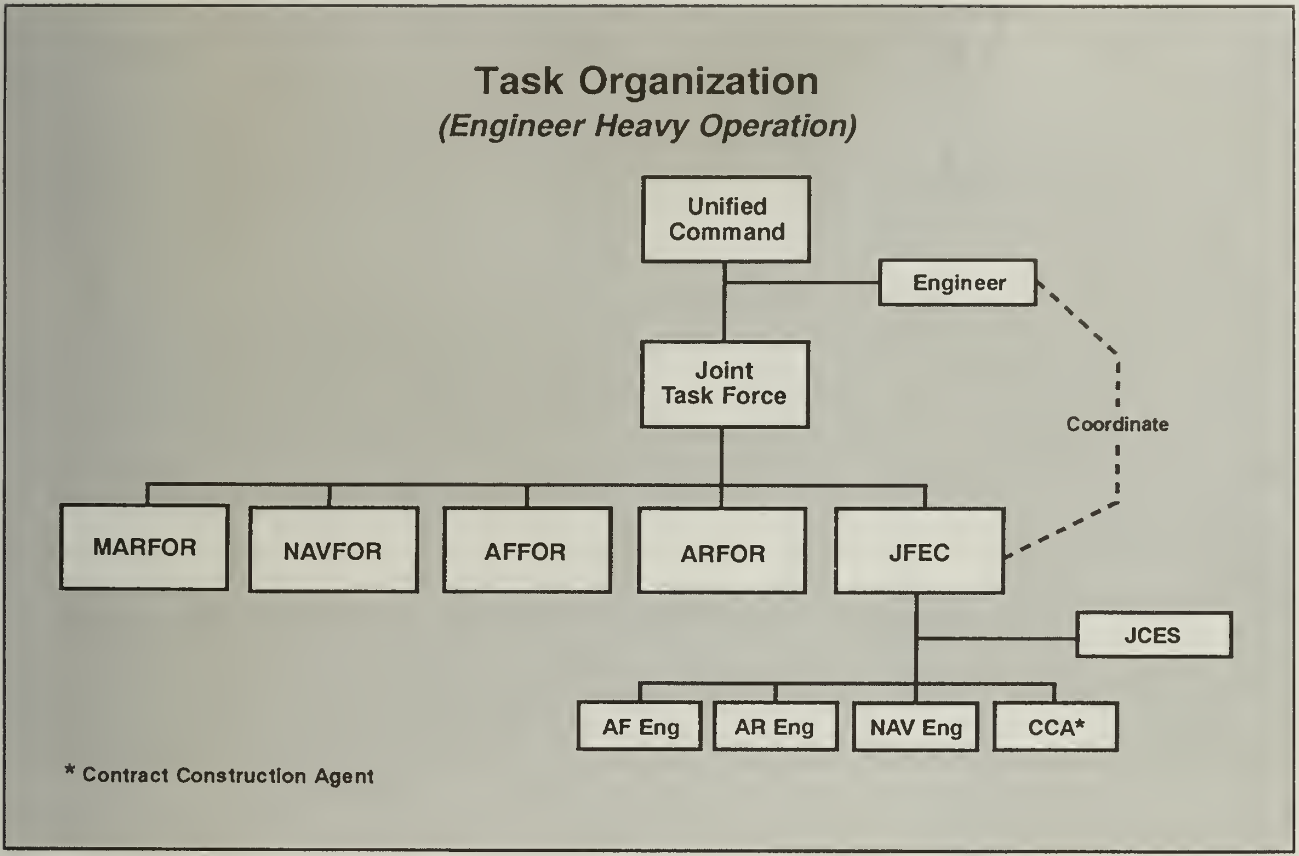
During Operation Provide Comfort, the 18th Engineer Brigade provided command and control for Army engineers, Navy Seabees, Air Force engineers, and engineers from other NATO countries. Recent experiences in Somalia[6] demonstrated the need for a theater engineer to ensure proper engineer coordination outside of the joint task force (JTF). During the deployment of the 43rd Engineer Battalion (Combat Heavy), confusing theater command relations made routine duties more trying than necessary. Out of frustration and a desire to simplify work, the battalion held weekly meetings with all in-country key engineers. As a result, communications flowed smoother, actions were expedited, and efficiency of work effort improved. A final recommendation by the 43rd was that in-theater staff engineers, military and civilian, meet at least weekly to coordinate efforts.

JFEC Concept. Thus, the stage is set for creating a joint forces engineer command (JFEC). A JFEC can exist only according to the provisions of Title 10, United States Code. The proposed JFEC would function under doctrine that governs joint activities and the performance of U.S. armed forces in joint operations. Additionally, the JFEC would operate under the doctrinal basis for U.S. military involvement in multinational and international operations. Today, joint service engineers train together in classrooms, exercise together in command post exercises and field training exercises, and deploy during times of crises to meet the military objectives of the National Command Authority. Each service component endorses the idea of jointness but, because of current doctrine, each remains focused primarily on service-oriented missions and functions. For jointness to become a reality in engineer operations, the above-mentioned requirements of U.S. law and joint doctrine must be met.

Because of the mission and current tables of organization and equipment (TOE) alignment, the Army's engineer command (ENCOM) is ideally suited to be structured as a JFEC. The ENCOM is a major subordinate command of the Army Service Component Command (ASCC) during war and operations other than war. The ENCOM commander has the rank equivalency of other subordinate commanders under the ASCC. For the force-projection Army responding to a major regional contingency (MRC), the ENCOM functions in a joint service environment. It also provides engineer command and control for engineer brigades and groups that provide engineer support at the operational level and support to the corps and divisions at the tactical level. Additionally, the ENCOM can provide staff support to the JTF or joint contingency engineer staff (JCES), as well as maintain an ENCOM headquarters to provide engineer command and control for the remainder of the theater.

In an MRC, the ENCOM commander could be dual-hatted as the JTF engineer and as the engineer troop commander. As recommended in the Operation Restore Hope Lessons Learned Report[7] for operations requiring a large engineer effort, a JTF engineer section should be established as a special staff group. In that case, the ENCOM commander, as a special staff officer, would report directly to the JTF commander. The ENCOM is then removed from the command and control of the ASCC and is placed under the command and control of the JTF commander. The JTF commander has responsibility for direct support to the operational area and general support to the tactical areas within the MRC area of responsibility (AOR). For operations where engineer efforts are key to mission accomplishment, the ENCOM commander, as a special staff officer, has direct access to the JTF commander for the assignment of engineer priorities for critical needs—such as transportation assets, Class IV supplies, and engineer equipment.

Doctrine. Joint Publication 4-04[8] authorizes the commander in chief (CINC) "to exercise directive authority over civil engineering within their AORs to ensure effective execution of approved OPLANs, provide efficiency and economy in operations, and prevent or eliminate the unnecessary duplication of facilities and overlapping of functions among service component commands." Further, the CINC has "the authority to transfer civil engineering functions between or among Service components within the AOR." Additionally, Joint Publication 4-04[9] states "peacetime organizations should be tailored and trained to meet those requirements." This concept of directive authority has been endorsed by USEUCOM, USLANTCOM and USPACOM in the Concept of Operations for Joint Forces Air Component Commander.[10] It states that the objective "...is to enhance the theater's joint warfighting capability by providing a framework for conducting coordinated and unified joint air operations and ensure that potential conflicts in priorities for the application or contribution of theater air assets are resolved efficiently and in the interest of the Joint Forces Command."



Proposed force structure for a Joint Forces Engineer Command

Proposal. Using this concept as a guide, a proposed joint engineer command and control structure, identified as the JFEC, is shown above. The JFEC consolidates all theater engineer planning and management considerations under its command and control. During contingencies (including major regional contingencies), the JFEC, as the theater engineer, exercises command and control for all joint engineer forces within the theater. Staffing for the JFEC is from all services. Staff training focuses on joint engineer support of joint operations during peace and war in a unified command's AOR. Ideally, the JFEC will be under the command and control of the subunified command responsible for providing all support to the deployed force. A JFEC develops the total Civil Engineer Support Plan and conducts the engineer preparation of the theater. This includes planning, coordinating, and supervising military, contract construction, and engineering services for U.S. and coalition forces in theater. The JFEC commander ensures that all engineer missions are fully planned, integrated, synchronized and executed to support the maneuver commander's intent.

Force XXI operations[11] require engineer forces to be more ready, more capable, more modernized, more integrated, and more available than ever before. This new joint-service organization, the JFEC, will serve as the engineer power-projection platform for the 21st century.

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Colonel James Robinson serves as Assistant Chief of Staff, Intelligence, 412th Engineer Command, Vicksburg, Mississippi.

Endnotes

[1] *ENGINEER*, December 1994, "Clear the Way".

[2] *ENGINEER*, December 1994, page 17.

[3] *ENGINEER*, August 1994, page 32.

[4] *ENGINEER*, December 1994, page 9.

[5] Ibid, page 17.

[6] *ENGINEER*, April 1994, pages 13-14.

[7] *Operations Other Than War*, Center for Army Lessons Learned, U.S. Army Combined Arms Command, page VII-5.

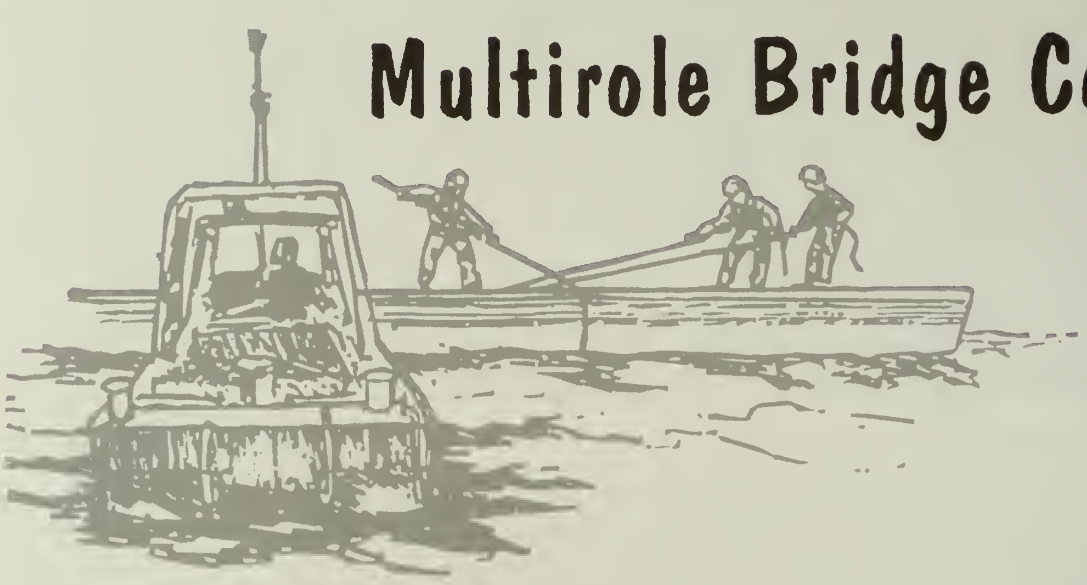
[8] Joint Publication 4-04, *Joint Doctrine for Civil Engineering Support*, page III-1.

[9] Ibid, page III-4.

[10] Joint Force Air Component Commander, Concept of Operations, USEUCOM, 21 October 1993.

[11] *Force XXI Operations*, TRADOC Pamphlet 525-5, 1 August 1994, pages 1-3.

The Emerging Multirole Bridge Company



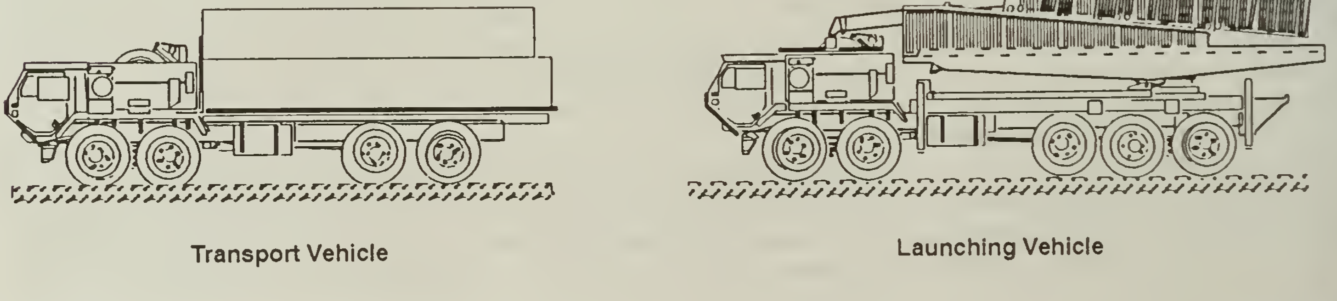
By Rebecca Johnson and Alan Schlie

These are exciting—yet challenging—times in the bridging community, with major changes facing the "bridge company" that exists today. The force projection mandated by Force XXI requires a refined focus for bridging. Our doctrine is sound; but there are ways to increase training opportunities, develop more knowledgeable leaders, and shift the focus of organizations to meld with the bridging systems forecasted for tomorrow's battlefield.

From the METT-T perspective of increased and more varied missions, a proliferation of enemies, an unchanging terrain, a reduction of troops, and compressed time schedules, it is clear that commanders must adjust the way they prepare for and execute bridging missions. Reduced budgets affect manpower, force structure, new equipment procurement, current bridge stock maintenance and storage, and training opportunities. The shift to CONUS-based staging and contingency planning means that U.S. forces will no longer have large numbers of readily available bridge units dedicated solely to either float or fixed bridging. This need for increased versatility will affect both the Active and Reserve Components.

The U.S. Army Engineer School is reevaluating how to meet the Army's bridging requirements and river-crossing operations for Force XXI and beyond. With the new integrated information processing systems of Force XXI, river-crossing opportunities will be quickly identified and execution will rely heavily on rapid-response capability for bridge companies.

Heavy Dry Support Bridge



Transport Vehicle

Launching Vehicle

Art courtesy Teledyne Continental Motors

Common bridge transporter with improved ribbon bridge interior bay

What has emerged from a study of this issue is the concept of a multirole bridge company (MRBC). The MRBC constitutes a standardized bridge company that is equipped with bridge-erection equipment and transporters; it is capable of constructing both fixed and float bridge sets much as a unit would expend a basic load of ammunition.

As now proposed, the multirole bridge company will be trained and equipped to install (assemble and disassemble) all types of existing and projected, prefabricated, U.S. bridging systems. The headquarters section will be able to perform the command and control functions necessary for the unit. Each bridge platoon will possess transporters, bridge-erection boats, and bridge-erection sets as organic equipment and will be capable of responding to platoon missions or combining for company missions. A support platoon will contain maintenance and equipment support, plus a small group to operate a bridge supply yard. A platoon receiving a mission will respond using an initial basic load of the desired bridge. When it completes the bridge, the platoon moves to the next site, either picking up the required bridge along the way or finding the bridge cached at the site.

As prefabricated bridging is replaced by nonstandard or more permanent bridging, the platoon will respond to bridge-retrieval missions. Retrieved bridges will reenter the supply system or be stored in the unit's bridge supply yard. The MRBC's capabilities will give commanders the ability to quickly maneuver and respond, through either fixed or float bridging or a combination of bridging appropriate for the mission.

This newly structured MRBC will operate within a "lane" on the battlefield (an area defined by a maneuver brigade's area of operation) and provide the necessary bridging for multiple axes of advance. Trailing closely behind the combat forces, it will move forward when necessary to support assault crossings. Additional MRBCs—provided from corps assets—may be assigned to the lane when gap-crossing requirements exceed the capabilities of a single MRBC.

During peacetime, the more flexible and versatile MRBC will also allow MOS 12C soldiers to improve their proficiency. Units will maintain an initial basic load of various bridge types in their storage yard in sets, by truckloads, with the fixed bridging remaining on pallets. Platoons will alternate through training cycles on the different sets. The dividends paid from increased training opportunities will provide an expertise not currently maintained by "single-specialty" bridge units.

During deployments, the type of bridge required on entering the theater will be uploaded first, with the remaining basic load from the storage yard following quickly and possibly becoming part of the unit's "footprint." The numerous types of bridges immediately available also will enhance the engineers' ability to respond to civic-action missions.

Medium-girder bridge

Final decisions as to the size and end-state composition of the multirole bridge company have not been made. However, many units can expect to have the heavy dry support bridge (HDSB) and the improved ribbon bridge carried on heavy expanded mobility tactical truck (HEMTT)-chassis transporters. Interim organizations will include basic loads of the medium-girder bridge (MGB), Bailey bridge, and ribbon bridge carried on the current transporters. Whatever the organization's stage of development, the multirole bridge company will not be dedicated to only one type of bridging. Bridge specialists must continue to be proficient in all types of prefabricated bridging.

An evaluation of the MRBC's command and control capabilities is scheduled during the 74th Assault Float Bridge Company's deployment to Fort Chaffee, Arkansas, in July 1995. Multiple missions of float bridging, fixed bridging, and logistics hauling will provide the basis for the evaluation and provide cross-training opportunities. The results and the experiences of the participants will be used to make final adjustments to the concept and doctrine.

MRBC engineers cannot exist on the battlefield without support from other branches:

- ***Quartermaster***—to order and track bridge stocks
- ***Transportation***—to haul replenishment bridge sets
- ***Ordnance***—to repair transporters, erection boats, and bridge components
- ***Air Defense Artillery***—to protect crossing sites during and after construction

Treating bridging as a commodity, instead of bridge company table of organization (TOE) property, will highlight the criticality of branch interaction and demand more notice at every war-gaming exercise. Missions executed on the battlefield must first be practiced in training exercises.

Versatility, as stated in FM 100-5, *Operations*, denotes the ability to perform in many roles and environments during war and operations other than war. It allows a smooth transition from one mission to another. Versatility requires competence in a variety of missions and skills, which suggests that all military organizations must have the ability to organize in various combinations and the capacity to redeploy from one area or region to another without losing focus. Versatility is the result of well-led, well-trained, and well-equipped forces; high standards; and detailed planning. Versatility ensures that units can conduct many types of operations, either sequentially or simultaneously, with the same degree of success.

Military bridging is a critical element in maneuvering on the battlefield. Since bridge construction is an engineer mission, the multirole bridge company will ensure the versatility engineer bridge units need to meet the challenges of Force XXI.

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Readiness: It's About Time!

By Colonel Carl A. Strock

In the short span of three months in late 1994, Army engineers from Fort Stewart and Fort Benning, Georgia, deployed on four no-notice, power-projection operations.

- In August, B Company, 92d Engineer Battalion (Combat Heavy), deployed to Surinam to construct a compound for Haitian refugees. Soldiers busily engaged in a local construction project on Friday found themselves in Surinam on Monday.
- September brought the late-breaking decision to include a mechanized company team as part of the invasion force going into Haiti. Within hours a reinforced platoon from A Company, 3d Engineer Battalion, loaded equipment on trains for movement to the Port of Wilmington. They subsequently deployed to join their equipment for what was planned to be an ongoing combat operation.
- When the phone rang in October, soldiers from the 11th and 92d Engineer Battalions were in the air, bound for Kuwait, in a matter of hours. Their mission was to draw and fight pre-positioned equipment to deter invasion of that desert kingdom.
- A few weeks later, the 317th Engineer Battalion deployed to Saudi Arabia to meet the inbound equipment on the Army's pre-positioned shipping.

A review of troop lists for other recent operational deployments reveals that Fort Stewart and Fort Benning are not unique. Why do engineer soldiers frequently find themselves far from home and in harm's way in spite of the promised peace with the end of the Cold War? More pointedly, what do these deployments imply for you, the Army engineer?

The answer to the first question is complex. East-West tension once kept military adventurism to a minimum with international actors tightly controlled by or indebted to one of the superpowers in the existing bipolar world. Use of force was often avoided out of fear that a conventional conflict would escalate to a nuclear exchange. During the Cold War, readiness imperatives weighed heavily on strategic forces with the required response time measured in minutes through the use of ICBMs, nuclear submarines, and strategic bombers. Conventional forces, bolstered by a large forward presence, had days or weeks to prepare and deploy under the nuclear umbrella.

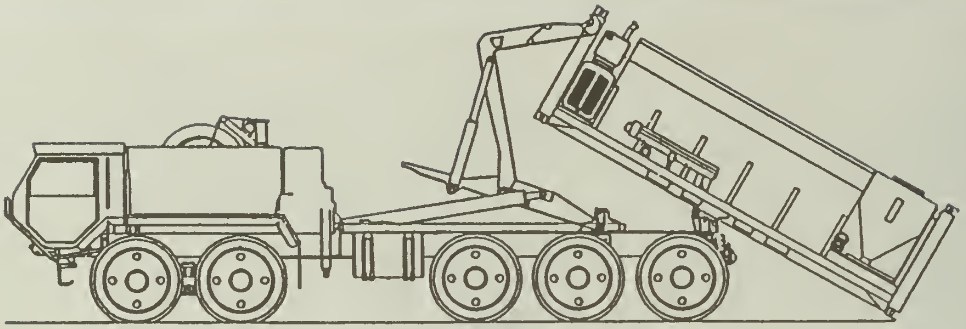
Today, in a multipolar world with more to gain and less to lose, regional actors often see force as an effective way to accomplish their objectives. Strategic forces have limited utility in today's policy of crisis response and power projection. Conventional, tactical forces now bear the requirement for rapid response—measured in hours instead of weeks or days—when U.S. national interests are threatened. An understanding of the role reversal between strategic and tactical forces leads to the second question, "How does this change affect you, the Army engineer?"

Simply stated, there is an increased probability that you will be called upon and that you will have little time to prepare. Whether you are a private or a colonel, active or reserve, light or heavy, carpenter or combat engineer, forward deployed or CONUS based, you must live the following five imperatives. They focus on war because that is the most challenging environment you will face. Your "war" may be a disaster-relief, humanitarian, or peacekeeping operation, but if prepared for combat, you will also be prepared for operations other than war.

Expect War. The drums of war are beating. Listen to them. Anticipate when and where the call will come. Develop and maintain a sense of urgency in your soldiers—that they will deploy some time during their tour of duty. The only unknowns are when, where, and by what means. Adopt the "wheels-up-in-18-hours" philosophy of our traditional contingency forces. With this sense of urgency, the next imperative easily follows.

Think War. The transition from garrison to combat will be rapid and dramatic. View your world from a foxhole perspective—that is, you must weigh every policy and procedure against its utility and practicality on the battlefield. Implied

(Continued on page 28)



Applying PLS Technology to the Engineer Fleet

By Alan Schlie

Unable to find parts for your old equipment? Too many old trucks in your motor pool? Too much low-density equipment? More equipment than you have operators? The critical mission item you need is running, but the truck it's mounted on has to go to 3rd shop! Frustrated? You bet you are! We've all been there. Why doesn't somebody do something about it? Well, now there's hope! The introduction of Palletized Load System (PLS) technology into the Army offers an opportunity to resolve some of these long-standing systemic problems in the engineer fleet.

Potential PLS Modules

General Construction

Bituminous distributor

Water distributor

Concrete mobile

Dump truck

Wood fabrication shop

Crane (20 ton)

Crane (7-1/2 ton)

Well-drilling rig

Pneumatic/hydraulic tool and compressor outfit

Pipeline construction

Bulk-water tank truck

Hydraulic excavator

Crane-attachment trailer

Cargo pallet

Tilt-bed equipment trailer

Rock crusher

Snow-removal equipment

Utility boom (cherry picker)

Other

Improved common bridge transporter

Topographic van

Wheeled unit TOCs (Bn, Gp, Bde)

Maintenance van

HYSTRU

Electrical maintenance van

Fixed-bridge launcher

Figure 1

The engineer truck fleet, even more than the earth-moving construction fleet, has never fared well in budgetary battles against combat weapons systems. The prevailing attitude has been that only minor purchases were required. Significant wartime needs were met by buying or leasing commercial equipment straight from civilian sources—buy it and paint it green. This attitude, of course, fails to consider the logistical and training impacts of not having the same models, in density, in the force. And since the engineer work-load package is secured directly to the chassis, there is no opportunity to replace that work-load package without also replacing the truck (or vice versa), significantly increasing the cost of replacing one system. Consequently, some engineer units in the Active and Reserve Components have M51-series, M817-series, and M929-series 5-ton trucks in the same motor pools, complicating repair parts stockage and training of both operators and mechanics. While some common trucks, such as 5-ton cargo and dump variants, have been replaced by more modern versions, other aging engineer-specific trucks remain in the inventory because of budgetary constraints.

All artwork courtesy Oshkosh Truck Corporation

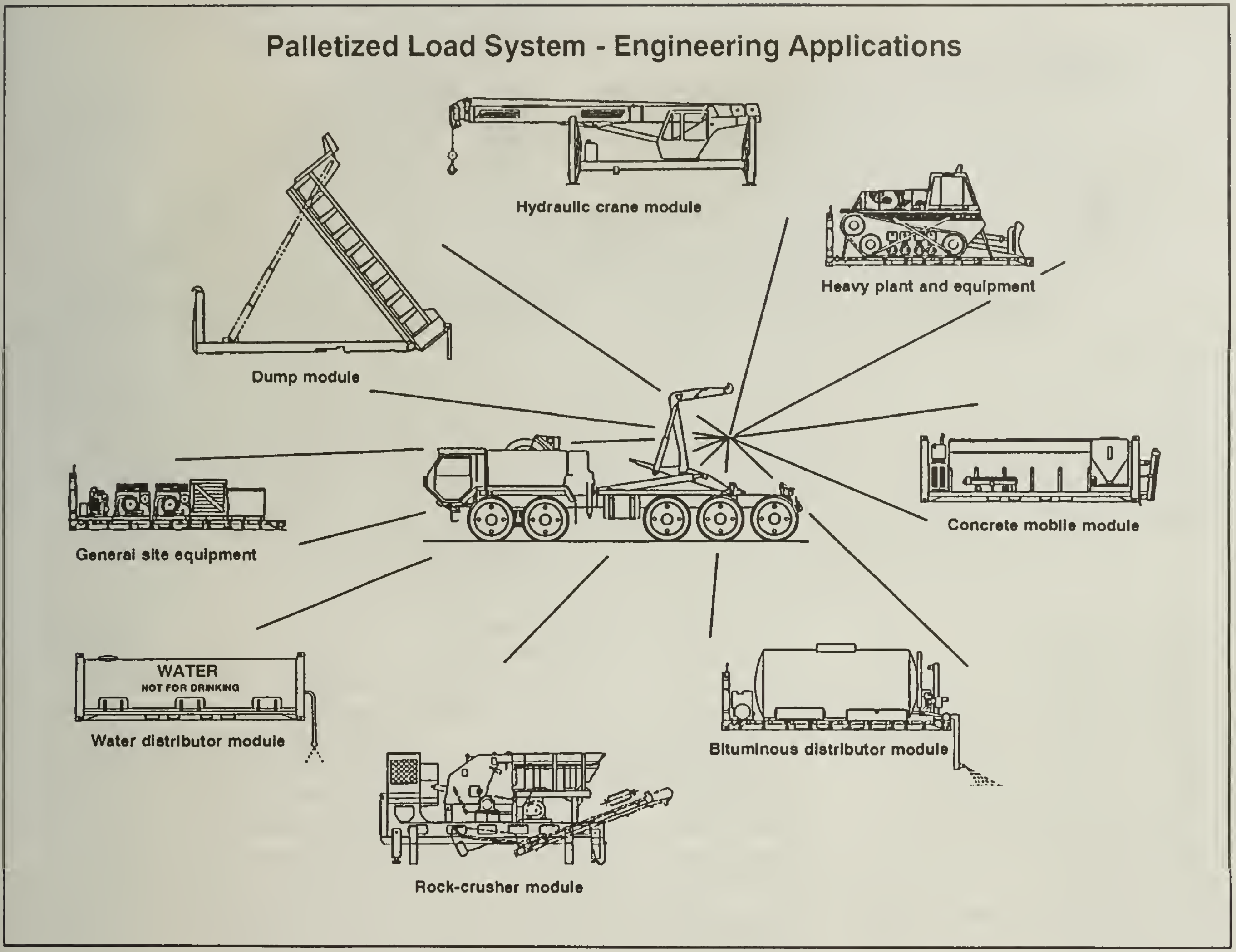


Figure 2

With decreasing procurement dollars, decreasing assigned and present-for-duty personnel strengths, and continuing pressure to train smarter with fewer training dollars, Army leaders now must consider all potential technological advantages.

Application of PLS technology to the engineer fleet could increase mission effectiveness by—

- Optimizing use of prime movers
- Increasing mission flexibility
- Increasing unit mobility
- Reducing maintenance burden
- Enhancing commonality with a modern truck fleet
- Reducing material-handling equipment requirements

PLS technology offers a potential for solving many of these problems by fielding a set of engineer work modules that can be uploaded on a truck chassis when required. Some possible applications are listed in Figure 1 and pictured in Figure 2. The PLS truck is a 16.5-ton-capacity vehicle that is capable of towing a 16.5-ton-capacity PLS trailer. Loads can be rapidly interchanged between the two. Enhanced mobility, central tire inflation (CTI), and built-in test are additional advantages of PLS. The manufacturer, Oshkosh Truck Corporation, is demonstrating the same palletized loading technology applied to the smaller heavy expanded mobility tactical truck (HEMTT). The HEMTT variant promises to be C-130 transportable, with a working payload of approximately 8 tons (Figure 3, page 26). Each of these payloads is attractive for engineer applications. For example, the 16-ton PLS can carry a heavy dump truck module, while the 8-ton HEMTT can carry a concrete mixer module. Either chassis can carry Class IV construction materials.

In the 1970s, the family of engineer construction equipment (FAMECE), a well-intended but ill-fated attempt to produce modular construction equipment, was developed—and canceled. How does this PLS approach differ? FAMECE was oriented primarily toward earth-moving equipment; this PLS effort focuses on truck- and trailer-mounted support systems. Most importantly, however, FAMECE was a complete developmental effort—including the

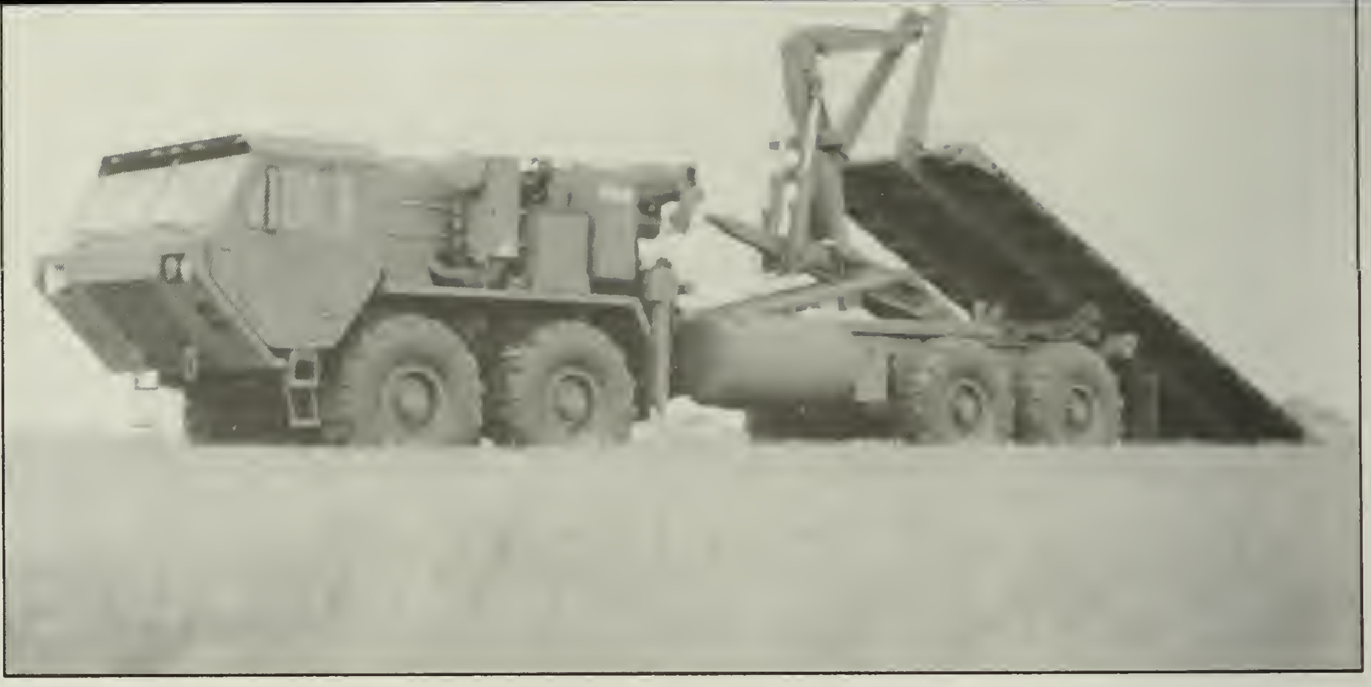


Figure 3. HEMTT LHS loading a cargo pallet

automotive design of the engine/transmission module and the complete design of the work module. In contrast, this PLS concept uses a proven and fielded truck chassis and lift mechanism. The only development required is configuring the work module loads to fit on cargo pallets (flatracks, in PLS jargon) or constraining them to the 20-foot International Standards Organization (ISO) container size.

Because of its cost, PLS is not likely to be cost-effective as a one-for-one replacement for any single truck-chassis combination. The potential for increased savings and effectiveness is in the use of interchangeable modules, keyed to unit mission demands. With PLS, fewer prime movers than work modules would be organic to each unit, reducing operating and support costs as well as operator requirements. For example, the available chassis could be equipped with dump bodies to conduct construction material haul missions. When required, one truck could download its dump module, upload a water distributor module, and provide water for on-site compaction, while most of the other trucks continued to haul fill. Two other trucks could download their dump modules, return to an equipment holding area, and pick up two compactors already secured to general-purpose PLS flatracks. After delivering the compactors, they could pick up their dump modules and continue to haul fill.

Some modules require the truck chassis to perform their mission. Dump trucks, water and bituminous distributors, and excavators are examples. Others, such as wood shops, maintenance shops, topographic equipment vans, power-generation sets, and rock crushers require the chassis only for transport to a work site. For these uses, the PLS trailer might be a better choice. After downloading the PLS module, the truck or trailer chassis would be free to load up a different module, thereby optimizing its value to the unit. Freestanding modules that require an adequate power source would have a power supply built into the module. For modules that operate while mounted on the truck chassis, electrical, hydraulic and/or mechanical power takeoffs and appropriate operator controls would be provided.

Dimensionally, the modules would be constrained during transport to the size of a 20-foot ISO container (approximately 20 by 8 by 8 feet). If a larger working size is required, the unit's sides could be extended at the work site, similar to the expando-vans already in the Army inventory. This efficient space utilization enhances deployment by using corps and theater transportation assets. Corps transportation units could provide transport for engineer units that require more than one lift to move in theater (as most engineer construction-type units do). A corps PLS truck company could augment the unit's organic assets to move the engineer unit. The many advantages of using a common, high-density vehicle include improved availability of repair parts and maintenance expertise.

Some of the engineer units appropriate for PLS applications are listed in Figure 4. While these units offer the greatest potential payoff for the investment, other units may also benefit.

As an example of the application of PLS technology, consider a combat heavy engineer battalion. More than 35 of these battalions are in the Army, most of them in the Reserve Components. Figure 5 highlights the major items that might be impacted by introducing PLS capability into these units. Note the quantity and variety of major items of equipment listed. Overall, introducing this technology will reduce the selected items of equipment from 79 prime movers (trucks and

Units Considered For PLS Technology

- Combat heavy battalions
- Wheeled combat battalions
- Combat support equipment companies
- Construction support companies
- Dump-truck companies
- Port construction companies
- Bridge companies
- Well-drilling teams
- Prime power battalions
- Fire-fighting teams
- Quarry teams
- Utility teams
- Topographic companies (corps and EAC)
- Pipeline companies

Figure 4

Impact of PLS Technology Insertion on an Engineer Battalion (Combat Heavy)

Selected Equipment Changes

Before	After
7 - Air compressors 250 CFM	7 - Air compressor modules
1 - 12-1/2 ton crawler crane	3 - Crane modules
5 - 25-ton cranes	2 - Excavator modules
6 - Shop equipment, wood	6 - Wood-shop modules
6 - Water distributors, 6000 gal.	6 - Water-distribution modules
3 - Forklifts	2 - Forklifts
3 - Concrete mobiles	3 - Concrete modules
9 - 20 ton dump trucks	9 - Heavy dump modules
2 - Bituminous distributor trucks	2 - Bituminous distributor modules
6 - SEE	3 - SEE
2 - Asphalt melters	2 - Asphalt melter modules
28 - Medium equipment transporters	22 - Medium equipment transporters
43 - 1 1/2 ton trailers	8 - 1 1/2 ton trailers
5 - 5 ton trucks	8 - PLS flatracks
3 - 5 ton tractors	20 - PLS trailers
3 - 10 ton flatbed trailers	20 - PLS trucks
1 - Heavy HMMWV with SICPs	1 - SICPs module
1 - HYSTRU	6 - HEMTTs with PLS capability
5 - Lube and service units	1 - HYSTRU module
6 - Contact trucks	6 - Contact maintenance and service modules
2 - Van semi-trailer, repair parts	2 - Repair parts stockage modules
1 - Shop equipment, electrical	1 - Electrical shop module
1 - Shop equipment, general purpose	1 - General-purpose shop module
1 - Shop equipment, organizational	1 - Organizational shop module
1 - 22 1/2 ton flatbed trailer	

Figure 5

cranes) and 72 trailers to 53 prime movers, 28 trailers, and 60 work modules/flatracks.

The Army is not on the cutting edge of this technology, nor is it the leading user. Municipalities were the first to recognize PLS-type applications in road and utility work, disaster response, and refuse collection. They have increasingly turned to these applications in the last few years because of budgetary constraints. Industry has responded by expanding the functions and capabilities of the modules available. The research and development have been completed; the Army now must define its requirements. The potential use of PLS technology on tracked vehicles and numerous light and medium trucks must also be investigated. Swedish industries already manufacture small vehicles with PLS, and English, German and French industries are investigating PLS dumping techniques. Four or five American firms offer modules for many engineer applications, such as dumping, rock crushing, lubricating, and lifting.

Much work remains to be done. More detailed analyses are required to determine the appropriate set of work modules, the mix in any given unit, the quantity and sizes of PLS-equipped chassis, the quantity of trailers, and the impact on unit maintenance and deployability. The Engineer School's Directorate of Combat Developments, in concert with the Program Manager for PLS, is initiating a study to answer these questions. Thorough unit mission analysis and the application of this technology will allow engineer units to be more effective, more flexible, and more prepared to support the Army in the next century.

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(Personal Viewpoint, continued)

in this imperative is the need to study doctrine and anticipate how it may change to accommodate the constantly changing face of warfare. The soldiers of the 92d Engineer Battalion were not intimidated by the prospect of deploying to the austere environment of Surinam because they had performed their peacetime and wartime missions using the same tasks, conditions, and standards.

Train for War. You will go into battle as you are—not as you would like to be. Make the training management principles expressed in FM 25-100 and FM 25-101 a reality. Use the available time efficiently. Base training plans on a solid assessment of mission-essential tasks and how well you can perform them. Continued force reductions make this task especially challenging because few units retain the luxury of a single regional focus. The engineer soldiers who deployed to the Persian Gulf were confident that they would succeed—even with the unknowns of pre-positioned equipment—because they were trained and ready for all contingencies.

Maintain for War. A well-trained, highly motivated engineer force is only as effective as its equipment allows it to be. View maintenance time not as a distractor but as an opportunity to build and sustain combat power. Without complete and operational machines, weapons, and tools, you cannot make a meaningful contribution on the battlefield. Assume that there will be no time to correct faults or make up shortages before your equipment is moved to the port or departure airfield. Ensure that the maintenance support organization is responsive, deployable, and easily tailored to meet the needs of your task organization.

These four imperatives are held together by the glue of engineer leadership.

Prepare Junior Leaders for War. Engineer leaders in squads and platoons execute drills and run work sites—the building blocks of successful engineer operations. Versatile, competent, innovative, and confident junior leaders are more important now than ever. The increased tempo of deployments and the relatively small scale of operations require junior leaders who can make important decisions without the benefit of senior guidance and in the absence of well-developed orders. Many recent crisis-response operations required platoon- and company-sized engineer forces to execute hastily developed plans. For example, the young second lieutenant who led his platoon into Haiti was the theater's expert on mechanized engineer tactics and equipment.

While many themes run through these imperatives, the common element is time. Readiness is about time. It is only a matter of time before you are called. When that call comes, there will be little time to prepare. As you climb into bed tonight, ask yourself whether you, your soldiers, and your equipment would be ready if the phone should ring at 0300. Then think about what you will do tomorrow to improve unit readiness. Only then should you allow yourself to drift off to sleep. Isn't it about time that you made a personal commitment to the readiness imperatives?

Colonel Strock is commander of the engineer brigade of the 24th Infantry Division (Mechanized). He previously served as commander, 307th Engineer Battalion, 82d Airborne Division, and was a participant in the Grenada, Panama, and Southwest Asia operations. COL Strock holds a master's degree in civil engineering from Mississippi State University and is a registered professional engineer in Missouri.

A New Paradigm for Topographic Support

By Lieutenant Colonel Douglas A. Campbell

The following information applies concepts described in TRADOC PAM 525-5,* Force XXI Operations, *1 August 1994, to topographic support. Other emerging engineer doctrine will adapt TRADOC's concept for Force XXI operations.

As the Army evolves to its new form, we engineers must evolve as well. The U.S. Army Engineer School is echoing TRADOC's call for a new paradigm for the way we organize, man, equip and operate the force. This new thinking reflects a change in focus from Cold War to contingency operations and the ascendance of information technology in warfighting. Perhaps the single most affected engineer mission in this evolution is topographic support.

In the past, the topographic engineering community often focused on materiel and systems development at the expense of doctrine, organizations and training. Consequently, topographic engineers missed many opportunities to develop the new approaches needed to accomplish their topographic missions.

The revision of FM 5-100, *Engineer Operations*, provides an opportunity to challenge old thinking and introduce a new paradigm for topographic support. Rather than simply restating old concepts that no longer apply to a smaller contingency Army battling for resources, this manual will provide the foundation for fundamentally altering the way topographic engineers support commanders. Every engineer must clearly understand this fundamental change if we expect to provide commanders with the terrain-visualization support they will need well into the next century.

To discuss the impacts of this change, we must understand the differences between the old and the new thinking. One way to do that is to list the key points of the current topographic support concept and those of the new paradigm. Then we can discuss the need for change one point at a time.

Current Concept	New Paradigm
Full deployment	Split basing
ENCOM	INCOM
Headquarters deploy	Liaisons deploy
Deployable boxes	Communications link
CBRS	COTS
Standard DMA data	Command satellite imagery
Direct support	Attachment
Corps companies	Theater companies

Split Basing Not Full Deployment

We must fundamentally reassess the doctrine calling for deployment of topographic engineer battalions and companies to the theater of operations. Instead, we should deploy small, capable packages and support those forward elements from a base equipped with communications links to them. There are many reasons for the split-base approach. One key reason is that we lack enough strategic lift assets to move entire topographic companies and battalions. Recent events in Rwanda, Haiti and Kuwait clearly demonstrate that lift, via sea or air, is a key resource in short supply. To complicate matters, the requirement to move essential forces to a given theater and sustain them must compete with humanitarian aid requirements for the same limited lift. The realities of politically dictated force ceilings require that planners move only mission-essential forces to a theater.

Some topographic elements, notably terrain teams, survey teams, and limited command and control personnel, should deploy early to directly support commanders. However, most of the topographic assets needed to generate data and produce map updates and map substitutes should remain at "home base." This is especially true given the large fleet of obsolete and difficult-to-maintain topographic-support equipment currently fielded with no replacements in sight.

The forward-deployed elements, squad-sized and smaller, can plug directly into the supported units. The ultimate goal is to provide maximum support to the theater with the smallest possible number of soldiers and equipment deployed.

The INCOM Not The ENCOM

Topographic engineers should link directly to the intelligence system. That system provides access to existing communications links, such as the Joint Deployable Intelligence System Service (JDISS), as well as all source intelligence. Additionally, topographic engineers primarily support the intelligence battlefield operating system and will work for the G2 or J2 on future operations. An ENCOM, as structured, offers nothing more than an extra layer of command and control and lacks the direct links to key intelligence nodes that are vital to generating support. Fortunately, the ENCOM issue becomes moot when we operate from a split base.

Liaisons Not The Battalion Headquarters

From a topographic-support standpoint, there is no reason to deploy a topographic engineer battalion headquarters to a theater of operations. We only increase the number of mouths to feed and headquarters infrastructure to support. Instead, we should deploy liaisons from the topographic battalion to each key supported unit. These liaisons would link with each other and with the support base via several established communications systems, such as JDISS. Attached to the appropriate staff elements of the supported units, the liaisons would provide the staff support needed to identify and manage topographic requirements. They would send requirements for logistics, personnel and topographic mission support to the base. The headquarter's staff then would coordinate support either from assets in theater or from the base. The advent of information technology, especially reliable systems such as JDISS, make this approach both possible and practical. It will enable us to place command and control for topographic operations into a theater at extremely low initial and subsequent sustainment costs.

Communications Not New Deployable Boxes

In the past, the topographic engineering community focused on developing and fielding "new topo boxes" to deploy to the theater. Those boxes were relatively large topographic support systems placed in trailers or vans. Today, we must focus on developing and exploiting communications capabilities that provide both topographic information and topographic command and control throughout the theater and the base. We can accomplish much of that requirement by piggybacking existing systems such as JDISS. Although the communications pipelines for transmitting large data sets are not yet accessible, we can get data to a theater quickly and reliably. Available systems include JDISS, commercial telephones with Stu III and fax/modem capabilities, electronic mail systems, courier and pouch systems to deliver CD-ROM data sets or special studies, and the Transportation Command (TRANSCOM).

TRANSCOM provides a communications means link that supports split basing. It is more cost effective to ship a pallet of maps than to ship the materials, personnel and equipment to produce that same pallet of maps in theater, especially since lithographic printing will continue to be the primary means for large-volume printing. Pallets of maps do not require food, fuel, extra paper, solvents, inks, and so on. The theater commander in chief or his joint task force commander will control the flow of support based on priorities he sets for the supporting strategic lift. We should build on the 1st COSCOM experience in the XVIII Airborne Corps as they move in a split-base direction for support to operations such as Uphold Democracy, in Haiti.

Topographic engineers must identify the communications nodes needed to tie the theater and the base together and then train soldiers to use them. That is METL (mission essential task list) training. This technique will enable topographic units to identify requirements in theater and communicate those requirements to the base. Base personnel will then produce the required support and ship it to the theater in time for use by the supported commander.

COTS Not CBRS

We must break away from the Concept Based Requirements System (CBRS) to develop and sustain topographic support capabilities. Commercial off-the-shelf (COTS) systems can accomplish almost all topographic missions. CBRS cannot keep pace with technology for the very small but rapidly evolving topographic support field.

The small number of topographic systems required by the Army means that CBRS and laboratory overheads will always be extremely high relative to the cost of the systems. Those overhead dollars could buy a lot of current off-the-shelf technology every year. We should resource a "skunk works" at the Topographic Engineer Center to leverage available commercial systems to support split basing. That organization could provide topographic units with small, easily deployed systems that allow us to keep pace with evolving technologies and effectively support commanders.

While the topographic engineer community has begun to adopt commercial solutions, one pressing issue remains. TRADOC rules have made it difficult, if not impossible, to train on commercial systems in TRADOC schools. At a time when technology is rapidly evolving, topographic soldiers are training on obsolete tasks and equipment in schools. Consequently, topographic units must bear the burden of developing and executing training on the commercial systems needed to accomplish missions. When we adopt the new paradigm, we must establish a more proactive approach to sustaining a viable training base.

Commercial Satellite Imagery Not Standard DMA Data

The Defense Mapping Agency (DMA) has the impossible task of attempting to produce and maintain standard topographic data sets to support contingency operations around the world. In a theater such as the Pacific, where there are few standard maps or standard data sets, we need an alternate approach. Topographic units can exploit commercial satellite imagery to provide commanders with terrain analysis or map substitutes. Imagery is much cheaper to provide than DMA standard data and can be updated simply by acquiring a new image. COTS systems can provide the capability to exploit this imagery.

Attachment Not Direct Support

The current doctrine stating that terrain teams must be in direct support and not attached does not pass muster. Terrain teams will respond directly to the supported unit commanders with whom they deploy. The topographic battalion will, in turn, provide backup support to the forward-deployed elements. Attachment also will provide those elements with needed logistics support. Topographic companies, less their forward-deployed teams, will provide general support and backup from the base. While the base can push some forms of support forward as well, the teams need not be in direct support to accomplish their mission.

Theater Companies Not Corps Companies

By accepting the new paradigm, we will no longer need to structure forces to provide a direct-support topographic company to each corps. Instead, we can keep a theater focus by having a topographic company form the base for split-base operations in a theater. Doctrine should acknowledge that Army topographic units will provide support to both joint and Army forces in a theater. After the concept is perfected, we can reduce the number of topographic battalions from two Active and one Reserve Components to one Active battalion. That one battalion will operate in a manner similar to the Corps of Engineers' prime power battalion: key assets will be forward deployed with commanders while a solid base provides backup. As the Army continues to get smaller, engineers must seek ideas like this to free resources for other key engineer missions. To succeed in such a restructuring effort, however, all engineers must fully embrace the new paradigm.

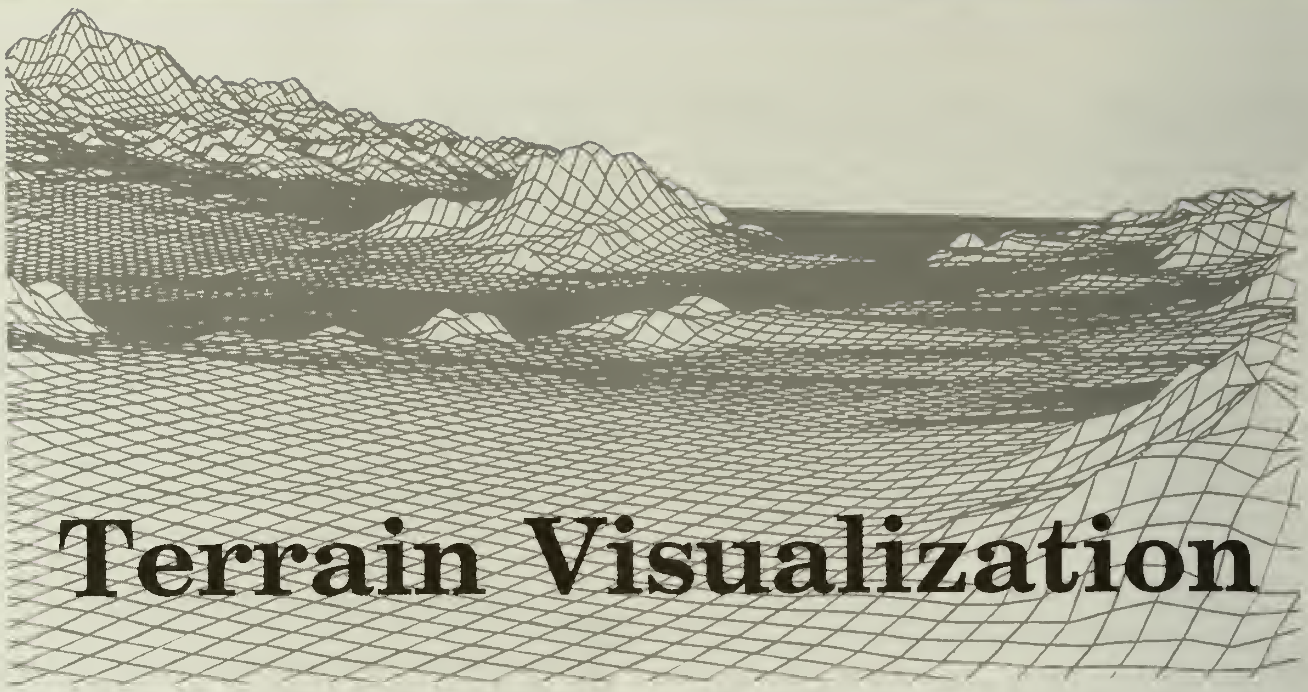
Moving Ahead (It Works!)

The new paradigm will work. In fact, the 29th Engineer Battalion has made major strides toward implementing it in the Pacific theater. We are a small battalion with one assigned topographic company. We have terrain teams and surveyors ready to deploy in small packages. We have piggybacked several key intelligence systems, including JDISS, and we regularly practice split-base communications. These changes have allowed us to develop and train liaisons for deployment to key headquarters. Because assessments indicate there will be insufficient strategic lift to move 750 tons of obsolete topographic equipment, we are organizing and training to provide additional support from the base. We write and ship CD-ROM imagery data sets for supported units throughout the theater. We have solid working relationships with the joint community and even have a full-time terrain team in the Joint Intelligence Center Pacific (JICPAC) and the PACOM Joint Task Force Augmentation Cell. We employ several COTS systems that are compatible with joint systems and rely on commercial satellite imagery as a primary data source. At the same time, we have deployable teams ready to support commanders with terrain visualization and IPB support.

What we need is for TRADOC and the Engineer School to acknowledge the new paradigm for topographic support. Then we can get the full weight of the doctrine and training base behind our effort. The new FM 5-100 provides the perfect opportunity to do so. As we turn this corner, topographic engineers will be able to support commanders well into the next century.

Lieutenant Colonel Douglas Campbell is Commander, 29th Engineer Battalion (Topographic) in Hawaii. He has served in numerous command and staff positions, including several as a topographic engineer. A graduate of the Command and General Staff College, LTC Campbell holds a master of science degree in civil engineering from Virginia Tech.

Terrain Visualization



By Captain Joe DeKeyrel

I have been reading science fiction since I was ten years old. I grew up with visions of soldiers wrapped in futuristic equipment to protect and inform them, slim formations with brilliant leaders who grasped every nuance of the battle before them. The premise of such leadership is that the leaders could "see" their entire area of interest, including friendly and enemy units, as well as terrain. The terrain piece belongs to the engineer.

As I was growing up, these images were suitably vague, with lots of flash and smoke but not much technical substance. As time passed and I continued to follow the spiraling technology devoted to the military, many of the old, vague visions of the future gained technical focus. Then, as the System Automation Support Officer for the Directorate of Combat Developments, U.S. Army Engineer School, I was tasked to bring some of these visions of the future into clearer focus.

The Vision

What I envision as an "ideal" terrain visualization system would allow—

- Input of Defense Mapping Agency (DMA) maps (as paper or ARC Digitized Raster Graphics (ADRG)), civilian "gas station" maps, satellite or aerial photography, and reconnaissance data.
- Rapid field updates of this data base and production of paper maps, raster graphics, and vectorized information.

Ideally, this system would smoothly and transparently operate with other systems to provide accurate, updated terrain data based on weather, traffic, and weapons effects. For example, soil trafficability would be affected by rain, large tracked formations moving over it, and loss of vegetation due to napalm or other weapons. The engineer terrain data base should be the common backdrop for all other visualization systems in use (such as intelligence, command and control, and mission planning and rehearsal). The complete system should consist of a large storage system (100+ Gigabytes), at least three workstations for scanning and vectorizing terrain data, a sheet-fed scanner, and a pair of printers for producing output. The software should take almost anything as source data and provide paper, raster and vector output with only minimal operator intervention.

Achieving the Vision

Almost all of the component pieces already exist for this ideal system. Using existing technology, Army engineers can provide a bewildering array of terrain-visualization products:

- Three-dimensional fly-throughs
- Overlays depicting go/no-go terrain
- Weapons line-of-sight displays
- Trafficability predictions based on vehicular movements
- Fog-coverage predictions from weather data

The only real shortfall is a fully automated way of generating the vectorized data base from raster sources.

There are dangers in building such a system. First, "techies" like myself tend to think that more information and better technology is *always* better.

Photo by Jim Anderson

MSG Ron Heupel uses a digital map scanner to prepare a paper map for a digital command and control background.

Obviously, this is a gross over-simplification. Having more of the type of data you need, logically presented and correlated, does help; but there are limits to what one person (the commander) can accept at one time. The second danger is that the system can grow into a technological showplace with capabilities that commanders may not need or want. To avoid these pitfalls, it is helpful to have input from the end users in the form of initial goals, as well as ongoing interaction throughout a project. We have assembled a system called the Rapid Army Combat Mapping Set (RACOMS) to experiment with mapping technologies to avoid these pitfalls.

Experiments

The Engineer School's involvement in terrain-visualization experiments began with the Louisiana Maneuvers (LAM). Our piece of the LAM experiment was to provide commanders with a common digital picture of the battlefield. Building on our LAM experiences, the U.S. Army, Europe (USAEUR) commander developed his vision and requirements for terrain visualization for his command. His requirements were broken into four stages for testing at a later date:

- Scan, update, and print paper maps
- Export updated map information as a raster background for vehicular command and control systems
- Vectorize updated information to provide terrain files for simulations systems (for example, the Urban Combat Computer-Assisted Training Systems (UCCATS)
- Accomplish these tasks/transformations for any location in the European Command area of responsibility within 120 hours

Even before the Engineer School became involved in experimenting with the Atlantic Resolve and USAEUR's goals, it wanted to test new hardware and software to support terrain visualization. To that end, the school purchased a Sun-compatible workstation as a test-bed system for exploring advanced cartographic and topographic analysis tools. The school also acquired a large-format color scanner that can scan an entire map sheet at once. ARCInfo, a geographical information system (GIS) and ERDAS, an image-processing package, were also installed.

The initial configuration allowed the school to scan an entire map sheet and perform any of the following functions:

- Print it in full color
- Save it into several standard data types
- Revise it by hand using a bitmap editor
- Print it at different scales
- "Stitch" several sheets together to provide a "seamless" map area

Any of these actions could be performed beginning with a set of ADRG data instead of paper.

The first practical application of the set was the creation of a special map for a National Guard unit whose assembly area is located in the corner of four standard map sheets. To create one special map, the four paper maps were scanned then registered with their latitude and longitude. Finally, the software warped the four sheets together. Once this was done, any subarea of the map could be retrieved. After selecting the area, the special map could be printed in color and as color separations for high-volume process printing.

RACOMS Components

Sun SPARC compatible, manufactured by Axil

4 50MHz, TI Super SPARC processors

64 MB of DRAM

1 GB and 9 GB hard drives

19-inch color display

36-inch by 24-inch, 400 dots per inch, drum scanner

Solaris 2.3 Operating System with Motif 1.4 as the Windows manager

ARCInfo 7.1

ERDAS Imagine 8.1

Various tape drives

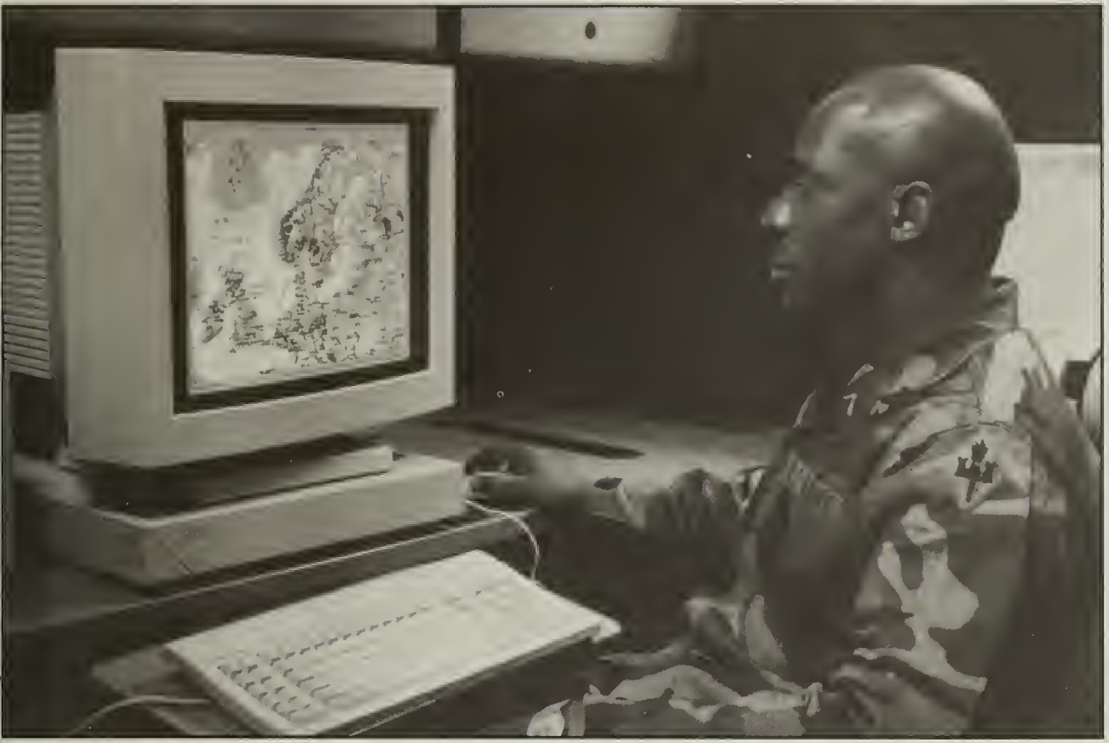
Read/write CD

ARCInfo allows any kind of data to be assigned to any location. The data could be an elevation, a slope, a vegetation type, an image, a sound clip, or anything that can be "contained" on the computer. Geographic locations are stored for points, linear features, and polygons, and data may be assigned to any of these features. After the data base is built, it may be queried in various ways. For example, after a road network has been entered into the data base, a movement-control officer could query the system for a route between two points that is hard-surfaced, has at least a 4-meter lane width, and crosses no bridges less than military load class (MLC) 70. After entering the query, the computer would show the routes between the two points that meet the criteria as highlighted lines. The Army could avoid the pitfalls of multiple standards and redundant data by drawing applications from the same data base. Some of these applications are route planning, terrain analysis, observation and fields of fire, and situational templating.

ERDAS can generate a very sophisticated map using land satellite (LANDSAT), Systeme Probatoire d'Observation de la Terre (SPOT) satellite imagery, or aerial photography. The process involves first rectifying and geo-referencing the image; then, using locations of known features (such as a hard-surfaced road, a lake, or a stand of deciduous trees) the software can classify the entire image by its "colors." Grid-lines, marginal information, and other map data can be added to produce a complete map product.

RACOMS Testing. Pieces of the RACOMS were tested at the Armor School and the Northern Lights exercise in April and June 1994. The entire RACOMS with full capability was assembled and tested in September at Fort Leonard Wood before it was sent to Germany to support Operation Atlantic Resolve. The first Atlantic Resolve test project was easy:

- Create a raster backdrop. A wealth of information can be stored in a vector data base, but we are accustomed to reading raster maps. Therefore, it is important to provide a "map" to overlay the vectors to provide orientation to the ground. The raster backdrop is created by importing files into ARCInfo that are in a tagged image file format. Once they are in ARCInfo, the files are registered (tied to specific locations on the ground) and rectified (changed from geographic coordinates to Universal Transverse Mercator coordinates). Then, any number of raster images can be merged to form a seamless raster backdrop.
- Create vector "coverages" showing such features as road networks, soil type, and vegetation. These vector layers make up the quantitative portion of the data base. Layers can be input from a digitizing tablet or created in a semiautomated way by scanning and machine-vectorizing line drawings of the features. For the Fort Leonard Wood area, these layers were digitized from the tactical terrain analysis data base (TTADB). The individual TTADBs were scanned, then vectorized using the ARCScan package. ARCScan allowed the school to vectorize a full 1:50,000 map sheet road network in about 30 minutes, as opposed to two to three hours to do it by hand. After the individual sections of a layer were created, they were stitched together to create continuous features (such as unbroken roads and rivers).
- Enter reconnaissance points from the tactical reconnaissance tool (TRT). The final task before going to Germany was to successfully import data points from the TRT, which uses a global positioning system (GPS) receiver coupled with a small computer to store locations and descriptions for points, routes, and polygons that can be coded in the field. A newer version will be linked to a stock-mounted, laser range-finder with an electronic compass. It will allow taking points from up to 2 kilometers away, a significant improvement for the soldier taking the data. The software that comes with the TRT allows a simple, 5-minute data conversion that results in a geo-referenced layer of data in ARCInfo format that can be overlaid on the existing data base with no further effort. A cellular modem allows information to be uploaded from the reconnaissance site.



SFC Braley McCutchen looks at an overview of an area of operation in an early phase of a field exercise.

Once the data base has been completed, it can be draped over elevation data taken from digital topographic elevation data so the entire terrain picture can be seen. The Korean data base will be demonstrated at the ENFORCE XXI Conference.

Louisiana Maneuvers Experiments. During the month in Germany, Engineer School personnel demonstrated the RACOMS to the Chief of Staff of the Army and the USAEUR commander, as well as to delegations from the German and French armies. However, most of the time was spent preparing products for Operation Atlantic Resolve, which took place on an artificial island called "Atlantis." Some of more than 400 projects completed during the exercise follow:

- Changed scale from 1:250,000 to 1:50,000 for several Atlantis map sections to provide special operations forces with usable products for their reconnoiters.
- Relocated an airport and created a fake road network to produce deception maps. The real airport was a reconnaissance target.
- Updated the road network for a city on an Atlantis map and added a bridge, using ground and satellite reconnaissance data as sources.
- Made several special maps from the Atlantis area, using both ADRG and paper maps as sources.
- Exported updated maps to ADRG format for use in command and control systems.

Summary

The Engineer School continues to improve the RACOMS. We are working to convert the ARCInfo vector files into JANUS and UCATTS terrain files, to facilitate simulations of specific courses of action on any terrain. The current setup is a one-of-a-kind test-bed system, although some of its capabilities are replicated in the field. USAEUR has procured several Sun systems, with slightly different configurations, and roughly equivalent setups exist at the Topographic Engineering Center and Waterways Experimentation Station. RACOMS functions will be fielded to the rest of the Army in a two-phased approach. This summer, all corps and divisions should receive their Digital Topographic Support System/Multispectral Image Processor (DTSS/MSIP) systems, which include the workstation, ERDAS software, and an output device. By late spring 1996, the "plus" upgrade to the DTSS/MSIP should be fielded, which adds ARCInfo and a scanner. So perhaps, in a small way, I have furthered the vision I had as a young boy—of "perfectly" informed leaders—by exploring one method of visualizing the terrain on the way to complete battlefield visualization.

Captain DeKeyrel was the System Automation Support Officer for the Directorate of Combat Developments before becoming the system engineer for a contractor at the National Training Center. Previous assignments include Platoon Leader, B Company, 44th Engineers (C)(H); and Commander, 902d Engineer Company (AFB). He holds a bachelor of science degree in mathematics from Virginia Military Institute.

Task Force Castle:

Joint Engineer Operations in Haiti

Photo by LTC E. T. Magdziak

By Captain Darren Klemens and Captain Kelly Slaven

The diverse challenges of Operation Uphold Democracy in Haiti required the largest OCONUS deployment of engineer forces since the Southwest Asian War. The 20th Engineer Brigade from Fort Bragg, North Carolina, served as the headquarters for Task Force Castle, which was a joint engineer task force of more than 2,500 personnel. More than half of these engineers came from Fort Bragg. Additional forces deployed from Fort Drum, New York; Fort Carson, Colorado; Fort Benning, Georgia; and Nellis Air Force Base, Nevada.

Task Force Castle spent almost two months in Haiti, providing force bed-down, survivability, sustainment, mobility and general engineering support to a joint and combined force of more than 20,000 soldiers, airmen and Marines. No engineer casualties or serious injuries occurred in more than 100,000 man-days of continuous operations.

Contingency Plans

Beginning in the winter of 1993, international attention focused on the human-rights abuse and general lawlessness of the presiding military junta in Haiti. As United Nations resolutions for positive change went unheeded, top-secret crisis-action planning began at many installations, including Fort Bragg. The XVIII Airborne Corps was given overall authority for planning contingency operations for intervention in Haiti. Only one or two brigade engineer planners had first-hand knowledge of revisions to many of the plans; therefore the brigade staff conducted initial planning under a previously developed contingency plan.

During the XVIII Airborne planning process, operation plan (OPLAN) X, a forced-entry operation featuring special operations forces and the 82nd Airborne Division, was downgraded from top secret to secret to allow a wider dissemination of information. Simultaneously, the 10th Mountain Division hosted parallel planning for OPLAN Y, a permissive-entry operation, with the 41st Engineer Battalion as the lead engineer element. While the conditions for the two operations differed significantly, many of the engineer-specific issues remained the same. They included determining—

- The engineer mission.
- The size of engineer force to deploy.
- Where the force would live.
- How much to upgrade/maintain the lines of communications.
- The military engineer end state.
- When and how to transition responsibilities to the Logistical Civil Augmentation Program (LOGCAP).

Alert/Predeployment

By September 1994, there was a tentative engineer task organization that could be used under either OPLAN X or Y. On 11 September, the 20th Engineer Brigade received an execution order for OPLAN Z, a merged version of the two plans, and the notified units officially began predeployment preparations. (Units participating in the deployment are shown below). As always, activities included obtaining shots, malaria medicine, powers of attorney, wills, life insurance updates, dental checks, packing lists, and contingency issue; verifying vehicle load plans; preparing POVs for turn-in; packing MILVANs; and staging equipment.

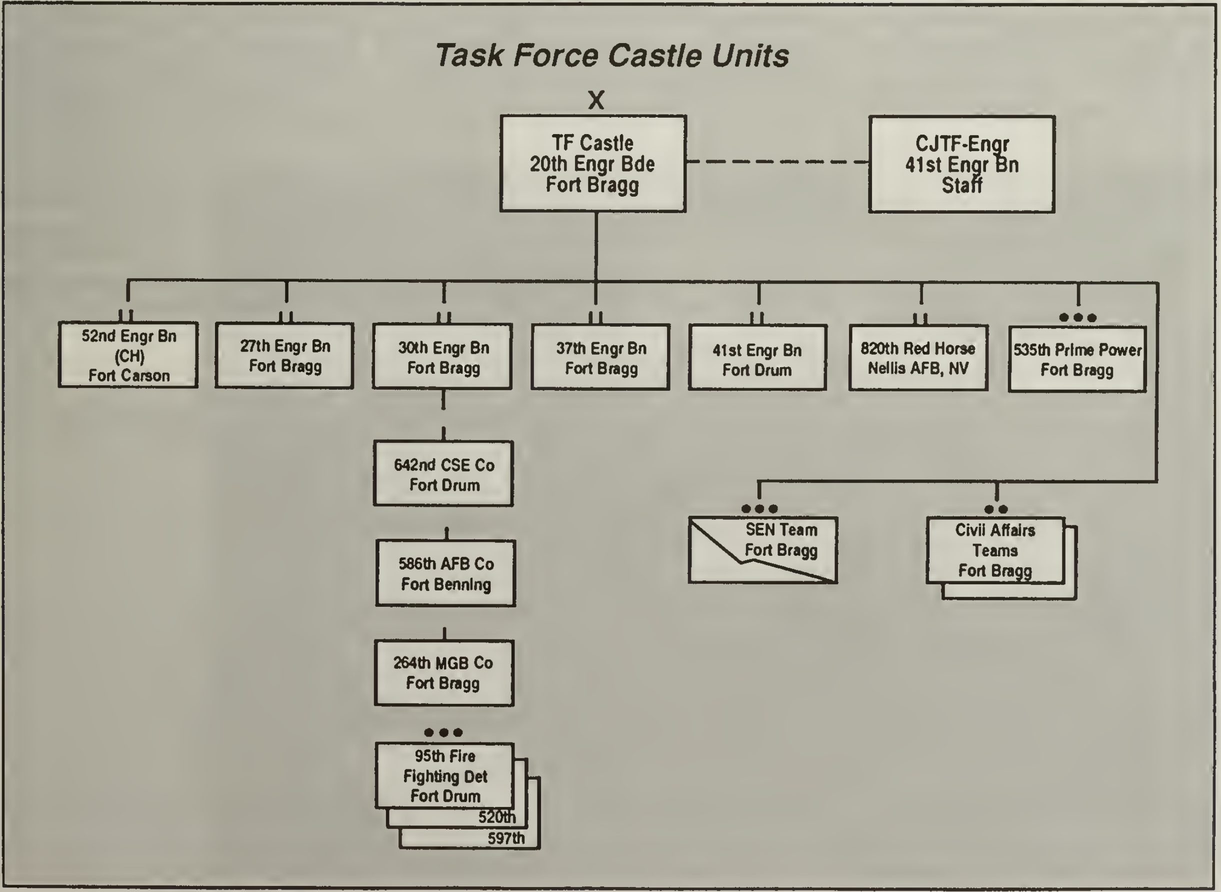
The Time Phase Force Deployment Data List (TPFDDL), a deployment planning and tracking tool, dictated which ship would carry each unit and how much cargo could be transported by strategic airlift. When the two OPLANs merged, the two TPFDDLs merged also. The resulting overlap caused units common to both plans to be listed twice, other necessary units to get dropped, and several unnecessary units to remain listed.

Deployment

The brigade convoyed to the seaport of embarkation at Wilmington, North Carolina. By 16 September, the equipment was loaded aboard ships, and the unit personnel waited for airlift. Successful negotiations at Port-au-Prince changed the forced-entry component of the operation and refocused the combat assets. As a result, the 82nd Airborne Division's prestaged heavy drop of equipment and resupply containers from initial staging bases returned to Pope Air Force Base. The resulting influx of planes clogged the air base and slowed the deployment for the first three days.

Initially, the 20th Engineer Brigade had a limited role in the forced-entry operation. They were to rig a heavy airfield repair package (HARP) for low-velocity airdrop into the international airport in case the limited assets of the 307th Engineer Battalion could not successfully open the flight landing strip to C-141 traffic. The HARP was forward deployed to an initial staging base at Dobbins Air Force Base, Georgia. Paratroopers from the 37th Engineer Battalion returned with their equipment, derigged it, pushed it to the seaport, and flew out with their battalion a week later.

After the equipment and personnel for an entire division were deleted, the TPFDDL became a hollow document. The brigade implanted itself in the Departure


Task Force Castle Units

Airfield Control Group by having air-movement-control NCOs take over the load planning and hazardous material certification stations early in the deployment. This allowed the brigade to monitor air traffic and infiltrate personnel into Port-au-Prince despite the broken TPFDDL. Most of the brigade arrived in Haiti by 27 September, and all of the Task Force Castle elements were in place by 1 October.

Initial Operations

Conditions in Port-au-Prince were Spartan during the first week of the deployment. The entire Combined Joint Task Force (CJTF)-180/190 arrived ahead of its logistical assets, leaving 15,000 consumers with very few providers. Fortunately, the situation improved daily throughout the first month as supplies and equipment arrived in Haiti.

The flow of engineers into theater was decentralized. Elements of the 41st Engineer Battalion conducted air assault operations into Haiti off the aircraft carrier USS Eisenhower. Their initial mission was to air assault into the international airport and port facility to clear and secure these facilities for follow-on forces. Engineer sweep teams cleared the main runway, apron, and taxiway, while an element from the 1st Brigade Combat Team (1 BCT), with sappers, cleared the port facility. After completing these activities, they began force-protection missions—constructing foxholes, fighting positions, berms, and wire obstacles. However, since there was no coherent opposing force, the engineer focus transitioned to base-camp development and force bed-down in the joint operations area. Under the permissive-entry scheme of operations, force bed-down became a real challenge because of land acquisition.

The joint task force (JTF) engineer staff, composed of the 41st Engineer Battalion staff with augmentation from other services, was responsible for acquiring real estate for force bed-down. The resident officer in charge of construction, an augmentee from the Navy, was delegated this task. The lack of infrastructure in Haiti made it difficult to find landowners and to obtain legal authorization to use property. Until land was acquired to construct semipermanent base camps, the 1 BCT bedded down on Bowen Airfield (a Haitian military facility) and the international airport near Port-au-Prince, while the 2 BCT bedded down at Cap Haitien.

The 20th Engineer Brigade occupied a warehouse acquired through contracting. It was located along the back wall of an industrial complex southwest of the international airport. The building served as the tactical operations center for the first two weeks and provided housing for soldiers arriving in theater. The 27th, 30th and 52nd Battalions remained in the Port-au-Prince area, while the 37th moved north to support 2 BCT near Cap Haitien.

Task Force Castle became a joint engineer task force with the addition of the 820th Red Horse Battalion from Nellis Air Force Base. The 820th focused on Air Force bed-down. It built a small base camp at the international airport and then improved it by flying in pea gravel for walkways and

The Combined Joint Task Force Engineer Staff Headquarters provided command and control for joint engineer operations in Haiti.

Base Camp Construction

Base Camp	*Occupant*	*Location*	*Constructing Engineer Unit*
Tiger/Dragon	1st Brigade Combat Team 1,000 Bangladesh UN soldiers 52nd Engineer Battalion 27th Engineer Battalion	1 kilometer west of Port-au-Prince airport	27th Engineer Battalion 30th Engineer Battalion 52nd Engineer Battalion
Mule Skinner*	10th Mountain Division Support Command (DISCOM)	North of Port-au-Prince airport	30th Engineer Battalion
Super	1st Corps Support Command (COSCOM)	East of Port-au-Prince airport	27th Engineer Battalion 30th Engineer Battalion
Falcon** Falcon West	10th Aviation Brigade 24th Infantry Division (Quick Reaction Force)	East of Port-au-Prince airport	27th Engineer Battalion 30th Engineer Battalion 52nd Engineer Battalion
Castle***	HHC, 20th Engineer Brigade 27th Engineer Battalion 30th Engineer Battalion	Suburb of Bon Repos, north of other US forces	HHC, 20th Engineer Brigade 27th Engineer Battalion 30th Engineer Battalion
Eagle	37th Engineer Battalion	Cap Haitien	37th Engineer Battalion
Commando I Commando II	2nd Brigade Combat Team	Cap Haitien	37th Engineer Battalion

*Its remote location led to a complete upgrade of the airport perimeter road.

**The location and heavy traffic led to renovation of the south airport perimeter road.

***Received the highest sanitation and standard of living inspection reports in Haiti.

spraying Road Oyl to keep the dust down.

While the remainder of Task Force Castle was at the port untangling the logjam of vehicles and engineer equipment that filled the port berthing yards (parking lots), the JTF Engineer was at the CJTF-190 headquarters sorting out a different logjam, the engineer concept. He defined the anticipated military engineer end state for forces in Haiti:

- Construct facilities for force bed-down
- Establish and sustain main supply routes (MSRs)
- Restore public utilities
- Complete high-payoff, low-cost humanitarian service projects

Decisive Engineer Operations

Decisive engineer operations began when the first piece of 27th Engineer Battalion equipment began leveling the field at the future home of Base Camp Tiger and ended when the 52nd Engineer Battalion completed its last construction directive with the JTF Engineer. In the intervening seven weeks, Task Force Castle performed a remarkable variety and amount of work.

Joint Operations Center (JOC). A priority vertical construction project was to upgrade the JOC/JTF-190 headquarters building. About 400 sheets of plywood and hundreds of 2x4s and 2x6s transformed the warehouse into a first-rate, temporary headquarters featuring dozens of offices, a video-teleconference cubicle, battle-staff cells, and a spacious conference and briefing room. Most of the work was performed by elements of the 52nd Battalion.

Hospital Upgrade. In another important renovation, the 27th Engineer Battalion constructed partitions, a litter access ramp, and a helipad for the 28th Combat Surgical Hospital. These improvements saved precious minutes in the aero evacuation of injured personnel from anywhere in theater to the treatment facility.

Interrogation and Detention Center. Across the street from the JOC, the 52nd Battalion turned a warehouse into a joint interrogation and detention facility for the 16th Military Police and 525th Military Intelligence Brigades. They constructed a series of common rooms, solitary cells, and interrogation booths and emplaced wire and other barriers to deter escape. Many former FRAPH, FAH'D, attaches and assorted hooligans were afforded an opportunity they could not refuse—to "visit" the facility and admire the 52nd's handiwork and craftsmanship first-hand.

Base Camps. The base camp construction program—nine base camps that provided housing for more than 12,000 soldiers—was the highlight of the brigade's success in Haiti (see table above). Basic requirements were—

- Readily available latrines and showers
- Wood floors, electric lights, and electrical outlets in all tents
- Adequate drainage throughout the living area

Working tirelessly, the four engineer battalions built over 30 kilometers of access road, graveled 10 square kilometers of parking area, fabricated hundreds of latrines and showers, built thousands of tent floor pads, leveled untold acres of land for living areas, and provided drainage.

The 27th Engineer Battalion clears an area for Camp Castle.

Electrical Power Restoration. Many of the missions performed in Haiti directly benefitted the local populace, but none were more dramatic or far-reaching than those performed by the Prime Power teams. Working with only 16 people, the teams quadrupled the electrical production in the Port-au-Prince area by firing up four existing power plants. They also traveled through outlying provinces to assess power generation, perform plant maintenance, and restore power. Towns that had been without electricity for as long as five years suddenly lit up. No single platoon-sized element in theater bestowed more goodwill or improved as many lives as this group of technicians.

Landfill. Port-au-Prince's primary landfill, located in City Soleil near the port, had outgrown its boundaries. The 30th Battalion built a new landfill, La Saline, north of the sprawling city, complete with a two-way access road.

Marketplace. The 27th Battalion built a new marketplace in Bon Repos, just north of Camp Castle, to ease relocations caused by construction of the base camp. The new marketplace soon expanded into a veritable strip mall as hundreds of vendors gathered to sell their wares.

School. The 27th Battalion adopted a parochial school in one of the most destitute areas of City Soleil. They constructed more than 100 desks for the impoverished school.

Garbage Removal. The 52nd and 820th Battalions fielded garbage removal emergency action teams to support the national cleaning fervor that preceded the return of President Aristide. Working with civil affairs personnel, these teams used small

The 535th Prime Power unit restored electrical power in several communities. This 22.5-megawatt power plant is in a suburb of Port-au-Prince.

Photo by LTC E. T. Magdziak

A crowd gathers at the City Soleil landfill to filter through garbage.

emplacement excavators (SEEs) and dump trucks to remove more than 200 tons of refuse from the streets of Port-au-Prince.

Police Training. The 52nd Battalion refurbished an academy for the International Criminal Investigators Training Assistance Program to use to train a new national police force.

Quarry Operations/MSR Upgrades. One of the 20th Brigade's earliest concerns was to find sources for crushed rock for horizontal construction. Scouting north up MSR 100, the brigade's construction cell discovered a quarry with a sizeable limestone deposit. They negotiated with the landowner/quarry operator and agreed to a flat rate of one US dollar per ton of rock removed. The 52nd Battalion operated the quarry around the clock while all three battalions in the Port-au-Prince area drew from it. After 200,000 tons of rock were removed, the landowner was a very wealthy man in the poorest nation in the Western Hemisphere. This was the largest military quarry operation in a tactical environment since the Korean Conflict. Together with two small quarries that produced nearly 35,000 tons of gravel for the 37th Battalion in the Cap Haitien area, they formed one of the most intensive quarrying operations ever conducted in the Caribbean area.

Class IV Supplies. Timely and adequate lumber delivery was as important to the vertical construction effort as limestone was to the horizontal work. Recognizing that nobody takes care of you as well as you do, the brigade decided to take responsibility for all Class IV supplies arriving in theater. Engineer brigade S4 representatives met each arriving ship; arranged common-usage land transport to shuttle the materials to Camp Dragon; employed most of the 264th Medium Girder Bridge Company to download, inventory

Photo by LTC E. T. Magdziak

A marketplace built by engineers in Bon Repos is dedicated at a ribbon-cutting ceremony.

Rock from this quarry operated by the 52nd Engineer Battalion was used to build roads and improve drainage.

and stock all the diverse products; and often shuttled the supplies to the brigade Class IV yard at Camp Castle. Thus, the brigade minimized construction delays caused by waiting for another organization to handle the materials.

Other Operations. The engineers also upgraded or maintained over 600 miles of road, surveyed over 1,900 miles of roadway, classified over 100 bridges, designed a dam for devastated farmers, reopened a local police station, and delivered at least one baby.

Redeployment

The redeployment TPFDDL showed engineers as one of the first major subordinate commands to depart Haiti. A well-defined engineer end state paid off when the drawdown began and the end state showed when the engineer force would complete its mission.

The S3 construction shop designed an equipment washrack for the entire JTF along the flight landing strip at Bowen Airfield, east of the port. Elements of the 586th Engineer Company brought in the first shipload of equipment; days later, the 27th engineers steamed through with the 30th engineers close behind, following a deliberate prewashing program. Camp Castle ceased to exist. Equipment was packed into boxes

Engineers construct a base camp for force bed-down.

and MILVANs, and the troops moved to temporary lodging at Camp Dragon to wait to load onto ships or planes. In Cap Haitien, the 37th Battalion washed their equipment near the port, formed their own port support activity, and loaded the ship.

By the end of the first week of November, all equipment destined for Fort Bragg was loaded on ships headed for Wilmington. Personnel from Fort Bragg arrived home by the end of the Veteran's Day holiday. The 41st and 52nd Battalions and the 642nd Combat Support Equipment Company were delayed in Haiti by a powerful storm that struck the island with torrential rains and high winds.

Engineer operations are still ongoing in Haiti. The 41st Engineer Battalion was relieved by elements of the 65th Engineer Battalion from Hawaii in mid-January. With the decreased number of construction assets, LOGCAP assumed responsibility for construction and several of the service and support missions.

Shaping Doctrine

Engineer experiences in Haiti epitomize the enormous combat multiplier that engineers represent. No other group in Haiti performed a fraction of the tangible work that Task Force Castle achieved. Their efforts translated directly into better living and working conditions for U.S. soldiers, United Nations forces, and the Haitian people. Task Force Castle's accomplishments serve as a textbook example of a successful contingency operation. The experiences of forces participating in Operation Uphold Democracy will shape engineer doctrine for operations other than war into the 21st century.

All photos by Captain Kelly Slaven, unless otherwise noted.

* * *

Captain Klemens is the S3 Air, 20th Engineer Brigade. He previously served as a platoon leader in the 37th Engineer Battalion (Corps)(ABN), Fort Bragg. A graduate of Michigan State University, he has completed Engineer Officer's Basic Course, the Sapper Leader Course and Pathfinder School and earned the Master Parachutist Badge.

Captain Slaven, an Instructor/Writer at the U.S. Army Engineer School, was a member of the Center for Army Lessons Learned Combined Arms Assessment Team that deployed to Haiti. He previously served as a task force engineer observer/controller at the Joint Readiness Training Center. He is a graduate of the Engineer Officer's Advanced Course and CAS3 School. Captain Slaven holds a bachelor of science degree in civil engineering technology from the University of Southern Colorado.

The ENGINEER Writer's Guide

We think engineers take a special pride in their profession, and *ENGINEER* is always looking for articles from readers who want to share their expertise, experience and ideas.

If you're a potential contributing writer, here are a few "writer's guide" tips that should help steer you in the right direction:

Articles may discuss engineer training, operations, doctrine, equipment, history, or other areas of general interest to an engineer readership.

We're especially interested in articles that have a "how-to-do-it-better" theme. For instance, we're not looking for articles telling readers how you conducted a routine field exercise. But if you think you have a "new-and-improved" way of conducting a tactical operation, training exercise, or other operational procedure that may prove helpful to other engineers—that's what we need.

Articles should generally come from contributors with first-hand experience with the subject being presented. Avoid theatrical writing styles like: "It was a dark and stormy night...," or "...the soldier blazed through the jungle on his lumbering D7, providing a trail of freedom for the other vehicles...."

Articles should be concise, straightforward, and in the active voice.

Length should range between 2,000 and 4,000 words, and the text should be typewritten and double-spaced. Generally, each such page will contain from 200 to 250 words.

Articles containing attributable information or quotations not referenced in the story should carry appropriate footnotes.

Manuscripts must be original, unpublished, and not under consideration by another publication.

All submissions are subject to editing.

Contributors are encouraged to include black-and-white photos, artwork, and/or line diagrams that illustrate the article.

Include your full name, rank, current unit and job title. Also include a list of your past assignments, experience and education; your mailing address; and commercial daytime phone number. Send your articles to: Editor, *ENGINEER* Professional Bulletin, ATTN: ATSE-T-PD-EB, Fort Leonard Wood, Missouri 65473-6650.

If you have questions about an article you're working on—or considering writing—call Cathy Eubanks or Shirley Bridges, at DSN 676-4104, or commercial (314) 563-4104. We look forward to hearing from you.

Lessons Learned

Engineer Synchronization

By Captain Whitney Wolf

> *"It was the old story of non-integration of the obstacle plan with the artillery plan and the company/team fire plans. There appears to be a basic misunderstanding concerning the use of obstacles. This trait has been exhibited by every rotating unit I have tracked at the Combat Maneuver Training Center. There is something basic that is broke (sic) in the training program for combat arms. The usefulness of obstacles is completely negated if they are not covered by some kind of fire. Every obstacle that is put in and not covered in a fire plan represents a criminal waste of time and effort. This waste will be paid for in dead soldiers and lost battles against any enemy force that understands its business."*
>
> *From a 1991 observer/controller internal report at the Combat Maneuver Training Center*

The Challenge

As operations research and systems analysts, our job is to confirm or deny a trend or suspicion of a trend by using some analytical method. In 1994, personnel in the Engineer School's Directorate of Evaluation and Standardization were tasked to determine why Army combined arms maneuver units succeed or fail to synchronize engineer planning and execution during combat operations. We thought of many possible reasons why engineers sometimes fail to operate successfully and why they sometimes succeed. At first it appeared to be an unanswerable question because, if we could determine the cause of all synchronization problems, somebody would have done so much earlier.

To find the answer, we used the archive of Take Home Packages, which outline the training performances of units rotating through the National Training Center (NTC). To accumulate a data base, we analyzed 34 staff elements operating at the NTC in 1991 and 1992 during their unit's first battle. We assumed that the first battle would indicate a unit staff's training level prior to deployment to the NTC as well as their readiness for deployment to a contingency operation.

After several weeks of research, a performance trend began to emerge. No single "magic" reason was found, but some common factors or actions did correlate with the units' ability to successfully coordinate planning and execute engineer tasks on the battlefield. The good news is that the answer to our question rests with basic tasks that all combined arms staffs should know and use.

Methodology

The 34 battles were rated as a success or failure based on mission accomplishment, battle losses, and the ability of each unit to conduct follow-on missions. Then we determined the effectiveness of the engineer staff officer and maneuver staff members in specific areas of coordination and synchronization. Often we found that the omission or lack of synchronized engineer support was highly detrimental to mission success, although some areas had less impact on battle outcome than others. By analyzing the degree of success in selected areas and relating those factors to the success or failure of the battles, we could see the significance of specific engineer activities.

While reviewing the reports, we focused on the following tasks and functions:

- The overall synchronization and execution of tasks by elements on the battlefield.
- The staff engineer's understanding of the maneuver commander's intent.
- Engineer integration into the intelligence preparation of the battlefield (IPB).
- Engineer integration into the functions of reconnaissance.
- Engineer support in obstacle and breaching operations.
- The effectiveness of the engineer estimate.
- Use of rehearsals.
- Use of brief backs.
- The degree to which obstacles were tied to direct and indirect fires.

A high correlation was found between the success of these activities and battle success.

Results

Success

Based on our analysis, the synchronization of engineer planning and mission execution generally will succeed when the combined arms team/task force—

- Exercises repetitiously as a complete combined arms team (with all Battlefield Operating Systems (BOS) elements represented) at their home station.
- Performs their staff planning exercises many times under a capable senior maneuver staff officer and with an experienced staff engineer officer.
- Applies the staff estimate process as defined in the Command and General Staff College Student Text 100-9.
- Effectively uses synchronization matrices.
- Conducts effective back briefs.
- Conducts effective rehearsals.
- Conducts effective staff huddles/information sharing.
- Performs staff cross talks.
- Possesses an efficient TOC setup.
- Ensures clarity in the stated commander's intent.
- Thoroughly understands the mission end state.

Failure

We predict that synchronization of engineer planning and/or execution of the combined arms mission will generally fail when—

- The engineer staff officer is not well integrated into the total staff as a team member.
- The engineer does not integrate the engineer battlefield assessment (EBA) into the IPB process.
- The engineer staff officer and the engineer units perform poorly during execution of the combined arms obstacle operations.
- The engineer staff officer and the engineer units perform poorly during execution of the combined arms breaching operations.
- The engineers do not participate in the combined arms team's rehearsals.
- The engineers do not back brief their leaders.

Statistics

If you are a numbers person, the following statistics will be of interest:

- A well-practiced total combined arms team had a 57-percent success rate. When the entire staff and all subordinate units did not use good synchronization techniques (such as staff huddles, efficient TOC layout, and an integrated staff-estimate process), the unit lost 80 percent of the time.
- When the engineers developed a substandard engineer battle analysis or engineer estimate, the unit had a 73-percent failure rate for that activity.
- When a maneuver commander's overall mission included a breach as a subtask and the breach failed, the overall mission failed 73 percent of the time.
- When the engineers provided good combined arms obstacle support, 100 percent of the battles were successful. This was the case in more than half of the battles included in this study.
- A successful battle resulted 83 percent of the time when rehearsals were done fully with all units of the combined arms team. This means they did not simply talk through the rehearsal or had only part of the units participating. When rehearsals were performed improperly, with each slice rehearsing separately, the units failed 85 percent of the time.

Recommendation

Apply these results! If you "think" your unit is ready for the NTC, it probably is not. Read the following excerpt from the study by Thomas J. Thompson, Robert J. Pleban, and Patrick J. Valentine:[1]

*"**Synchronization of staff functions.** The battalion staff members who completed questionnaires and were interviewed prior to their CTC [combat training center] rotations generally felt that they received adequate time to train as a staff and with the combat support and combat service support slice elements as well. In questionnaire and interview responses after the rotations, these same staff members expressed more concern with the infrequency with which they had trained. This was particularly true with engineer, aviation, and fire support elements...It was typical across battalions that respondents only realized the existence of shortcomings in staff preparation after their CTC rotations. This suggests that the CTC continuous operations environment, which was not under the control of the battalion or its parent unit, was needed to reveal the true status of training within the staff."*

(Continued on page 57)

Tactics for Route Clearance

By William C. Schneck, Jr., and Brian M. Green

In Somalia, military police used mine detectors to sweep for command-detonated mines. This tactic for searching for command-detonated mines, as opposed to searching for their firing wires, is both dangerous and unnecessary.

Somalia was not the first military operation where American lines of communication (LOC) were mined.[1] Although GIs in World War II and the Korean Conflict experienced their share of mine incidents, U.S. forces in Vietnam routinely faced the threat posed by mines and ambushes along their LOC. Through trial and error, GIs have learned to operate in this difficult environment, and their experiences have produced many useful lessons regarding command-detonated mines and route clearance.

It is not possible to completely eliminate losses from mines, but commanders can take steps to significantly reduce them. Appropriate tactics combined with an aggressive training program for all personnel in theater can effectively reduce casualties and equipment losses. Experiences of U.S. forces in Vietnam and Somalia demonstrated that to ensure success, route clearance must be treated as a combined arms combat operation. Infantry, armor, engineer, artillery, aviation, intelligence, and military police support must be carefully planned and executed.

The route-clearance tactics described in this article and shown in Figure 1 and Table 1 (page 48). portray an ideal situation where optimum support is available. When tasked with a route-clearing mission, commanders can adapt the following critical mission elements and tactics to local conditions and the resources available .

Route-Clearance Techniques

In Vietnam, U.S. forces developed three viable techniques to clear routes: the deliberate sweep, the hasty sweep, and mine reconnaissance (recon).[2] Sweep rates for these techniques are shown in Table 2, page 48. The techniques may be useful in some situations in today's post-Cold War environment.

Deliberate Sweep. A deliberate sweep is a route clearance operation against a high-threat insurgent. It normally requires a reinforced infantry company team that is supported by artillery and helicopter gunships. A reserve should be held at the maneuver battalion level, ready for immediate commitment.

If the situation permits, the commander should task subordinate units to conduct a deliberate sweep when a road is initially opened for traffic, when mining is suspected and, if possible, every morning thereafter. A deliberate sweep has five elements:

- Positioning the troops
- Securing the route
- Clearing the road
- Running the convoy
- Rolling up the forces

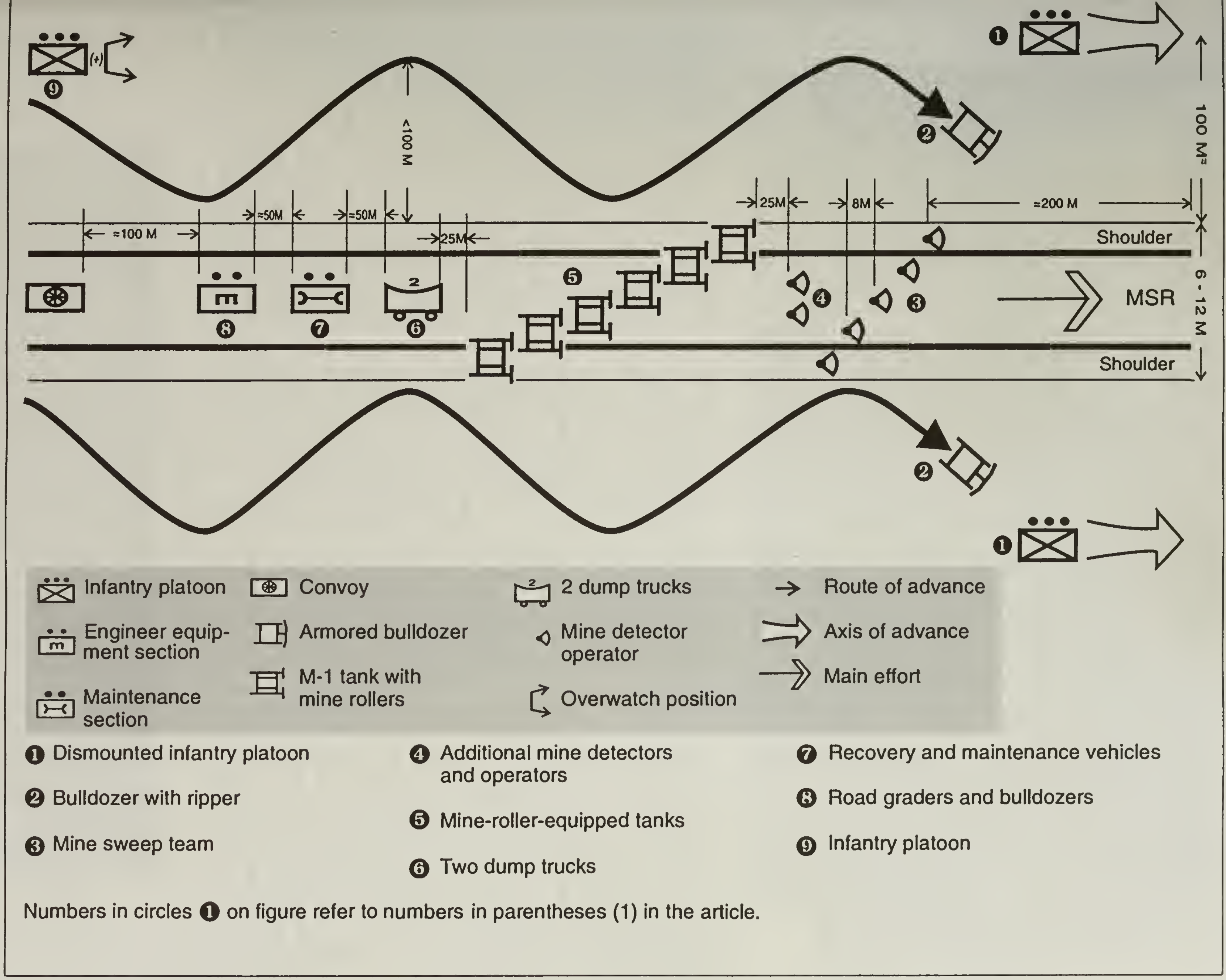


Figure 1. Infantry company team conducting a route clearance operation.

Table 1. Task organization of an infantry company team tailored for route clearance against a high-threat insurgent

Unit	*Reference (Figure 1)*	*Unit*	*Reference (Figure 1)*
Company command post	9	Infantry platoon (+)	9
- Mortar section (if available)	9	Armor platoon (+)	5
- Antiarmor section (if available)	9	Engineer platoon (+)*	3, 4
Infantry platoon	1	- Equipment section	6, 8
- Engineer team	1	Maintenance section	7
- Armored bulldozer	2		
Infantry platoon	1		
- Engineer team	1		
- Armored bulldozer	2		

*Route clearance is identified in the mission training plan as a task to be accomplished only by an engineer squad.

Because the first, fourth, and fifth elements are relatively routine for all combat units, only securing the route and clearing the road are discussed in detail.

- *Securing the Route.* The company team performing a deliberate sweep advances astride the main supply route (MSR) in an inverted V-formation (Figure 1). A dismounted infantry platoon (1) with an attached combat engineer team moves along each flank while carefully searching for wires and other signs of command-detonated mines or ambushes. The two infantry platoons should be far enough ahead of the engineers and the tanks of the sweep team to investigate possible sites where the enemy could observe the sweep team and activate a command-detonated mine. If the infantry platoon is near a tree line, a security team should sweep the tree line ahead of it.

The effectiveness of this flank security as a countermeasure to command-detonated mines can be significantly increased by following up each platoon with a bulldozer (2) equipped with the mine-clearing/armor protection (MCAP) kit or improvised armor.[3] The bulldozers should be equipped with single-tooth rippers that can cut a narrow, 24-inch-deep trench and cut or uncover the firing wires to command-detonated mines (Figure 2). An M9 ACE fitted with an improvised single-tooth ripper is also well suited to this task. These vehicles may be employed as far as 100 meters off the road, terrain permitting, and should zigzag their routes to locate firing wires laid parallel with the road.[4] Roller-equipped tanks should precede them when antitank mines are expected off-road. If vehicles fitted with single-tooth rippers are not available, dismounted personnel with the flank security elements can accomplish a similar effect by dragging picks along the ground.

- *Clearing the Road.* The minesweep teams (3) move down the road at the point of the inverted V-formation. FM 5-34 recommends one sweep team of eight engineers for every 2 meters of road width, including road shoulders. Depending on the width of

Table 2. Mine sweep rates

Sweep Type	Era	*Sweep Rate (kph)*
Deliberate	Vietnam	0.25
Deliberate	Current	1-3
Hasty	Vietnam	1-3
Hasty	Current	3-5
Mine recon	Vietnam	15

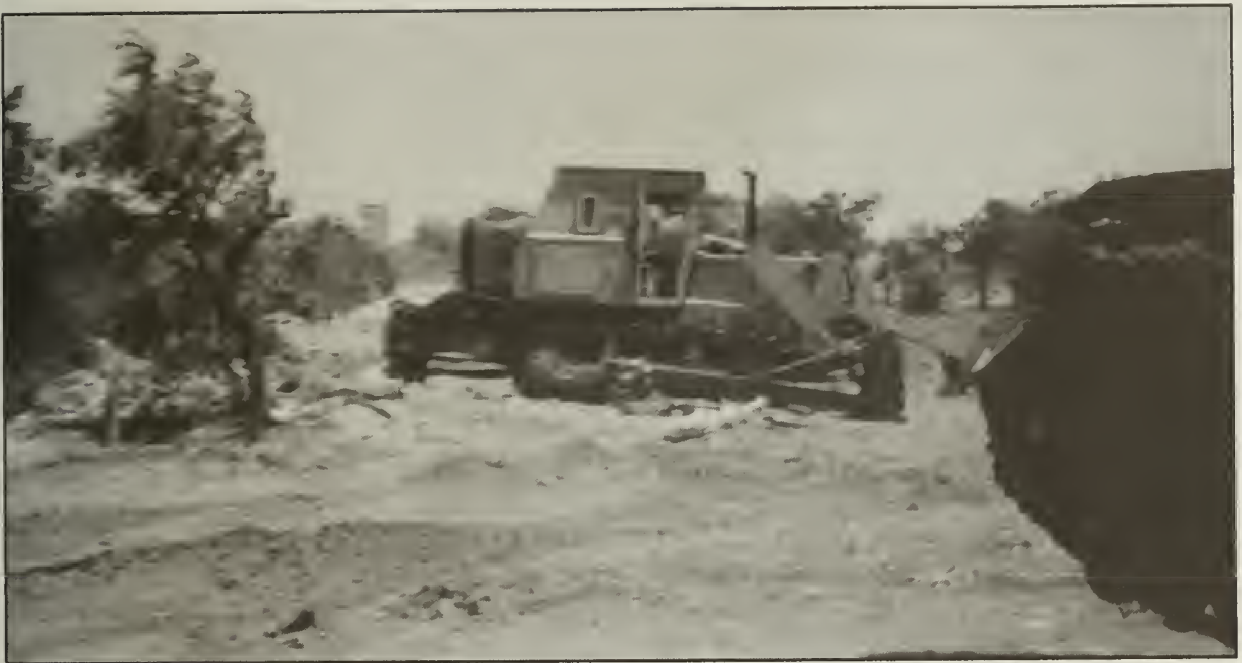


Figure 2. This Pakistani D7 bulldozer is equipped with a ripper fitted with MCAP. While used to clear roadblocks in Mogadishu, it is also well suited for locating firing wires.

the route to be swept, the engineer platoon may need to acquire additional detectors from its parent or supported unit to perform this mission.[5] Demolition and local security teams may support more than one sweep team. When they do, the number of engineers can be reduced by as much as 25 percent.

To eliminate electronic interference between mine detectors and to reduce the possibility of multiple casualties from an accidental mine detonation, echelon the sweep teams with an 8-meter interval between detectors. Two additional mine detectors and operators (4) should follow them. The additional assets provide a reserve that allows the recommended rotation of operators approximately every 20 minutes and may reduce the time needed to sweep difficult areas such as culverts and bridges. These teams should be augmented with EOD personnel if they are available.

Proofing devices such as mine-roller-equipped tanks (5) follow the sweep teams. Loaded 5-ton dump trucks driven in reverse (to reduce the possibility of driver injury in a mine detonation) or some type of improvised, easily repaired mine roller (Figure 3, page 50) may be fabricated and used as an expedient. A wrecker and a truck carrying repair parts and maintenance personnel should follow the roller.

When improvising a roller, design it for a vehicle 5 tons or larger in size. To avoid driving over unproofed ground during turns, consider the vehicle's turning "footprint" in the design process. A sheepsfoot roller is an effective expedient against pressure-fuzed mines.

Deploy the proofing devices in echelon to provide complete coverage of the road and the road shoulders. Because of the track-width coverage of rollers in the Battalion Countermine Set, three M1 tanks equipped with mine rollers are required to fully proof a road up to 6 meters wide, and six M1s are required to proof a road 6 to 12 meters wide. The Battalion Countermine Set issued to M1 tank units contains only four sets of rollers. Because divisional MSRs are usually more than 6 meters wide, units may need to acquire additional assets from another armored battalion or improvise some other means of proofing.

Tanks are vulnerable to command-detonated mines, and the flank security elements and the sweep teams should always precede the tanks if such mines are expected. It would be tragic as well as embarrassing if CNN broadcast footage of a multimillion dollar M1 and its highly trained crew that had been destroyed by an improvised mine costing less than $50. The proofing vehicles should maintain an interval of 25 meters between each other and from all dismounted personnel to lessen the possibility of casualties if an undetected mine detonates.

If the enemy is expected to use roadblocks, support the proofing vehicles with a CEV, an M9 ACE, or an armored bulldozer. These vehicles can push a roadblock out of the way after the sweep team has thoroughly checked it for mines and booby traps. In Vietnam, the Vietcong emplaced roadblocks in-depth but only mined or booby-trapped the last few.

Two dump trucks (6) loaded with gravel to fill craters and chuckholes follow the proofing vehicles. Areas over culverts and road repairs should be capped with asphalt or quick-setting concrete to make enemy mining more

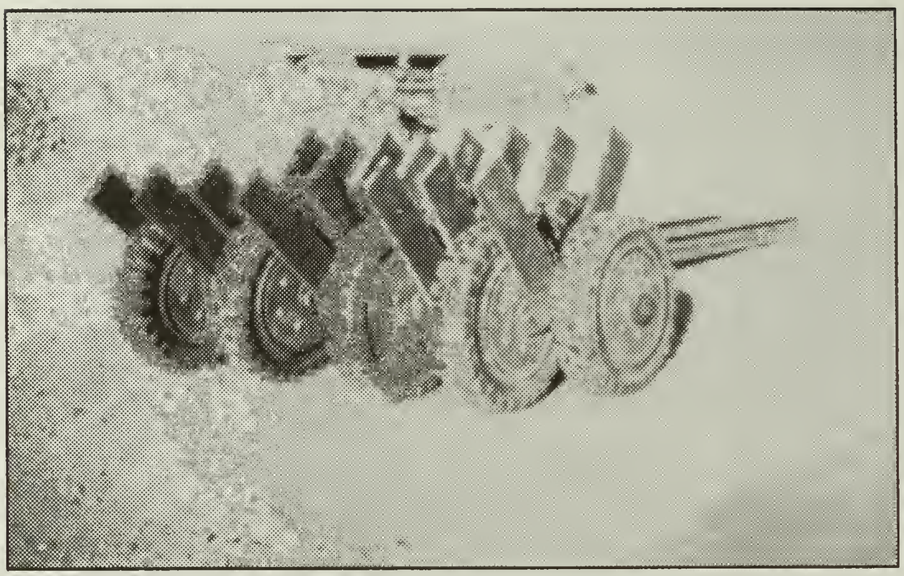


Figure 3. An improvised mine roller built by the 27th Airborne Combat Engineer Battalion for Operation Desert Storm.

difficult to perform and easier to detect. Recovery and maintenance vehicles (7) follow next and, if necessary, graders and bulldozers (8) follow them to improve the road surface and drainage.

The company command post (CP) should accompany the last infantry platoon (9), which provides overwatching fires to the flank security and the sweep teams throughout the operation. If the CP and infantry platoon are mechanized, they remain mounted. The commander must carefully synchronize the movements of this platoon to ensure a continuous overwatch without disrupting his covering fires and the progress of other subordinate units. One way to do that is to bound part of the overwatch team forward while the remainder continues to provide covering fires. The remainder of the platoon bounds forward only after the other overwatch element is ready. If Bradleys or M113s are assigned to the dismounted platoons, they may either follow those platoons to provide close support or position themselves with the overwatching platoon to increase its firepower.

The entire column on the road, from the lead sweep team to the last piece of engineer equipment, is about 500 meters long. If lead security elements are included, the formation is about 700 meters long. These figures do not include any convoys that follow the route sweep.

After the sweep is completed, engineer road repair teams must be on call to repair any subsequent road damage.

Despite the repetitious nature of route clearance, soldiers must remain alert and dispersed at all times. In any other posture, they are subject to multiple casualties from ambush or command-detonated mines.

Cities and other terrain with narrow avenues of approach and restricted fields of fire present a very difficult challenge in route-clearance operations. Units operating in such terrain may need to modify their route-clearing tactics to fit the situation, but the key point is to find the firing wires to command-detonated mines before the mines are found. Because intense close combat is likely to occur during route clearance, commanders must emphasize survivability and firepower when selecting units and equipment for such missions.

Hasty Sweep and Mine Reconnaissance. The existence of hasty-sweep and mine-recon procedures is a tacit acknowledgement that the "100 percent solution" usually is not feasible and that commanders must accept a reasonable amount of risk. As always, the commander must determine the proper balance between risks and requirements. The tactics used for a hasty sweep and a mine recon are based on those for the deliberate sweep but are modified to meet time and resource constraints.

In a hasty sweep, mine detector operators walk at a normal pace, sweeping back and forth. They must check suspicious areas thoroughly.[6] A hasty sweep may be conducted in the morning before routine convoy operations begin, or the sweep team may lead the convoy during movement.

In some situations, commanders may use a mine recon instead of a hasty sweep. For example, a mine recon may be used on a heavily traveled MSR that has had no mine incidents for some time, a previously swept hard-topped MSR, or an MSR that is secured by friendly troops along its entire length.

In a mine recon, a mounted engineer team slowly drives over a route before it is opened to daily traffic to look for evidence of mining activity. The team should dismount and thoroughly sweep suspicious areas. In another method of mine recon, engineers are placed in the lead vehicle of a convoy to watch for mine indicators. To be effective, these techniques must be used at speeds less than 15 kilometers per hour.

Beginning in January 1994, commercial infrared cameras were used to augment mine recons performed in Somalia. These cameras were effective at finding buried mines on roads from a standoff of about 30 meters. Their performance, however, was significantly degraded in windy or rainy conditions or where vegetation grew close to the mine. The infrared cameras did not increase the

Table 3. Methods of decreasing vulnerability to mines

Method	*Remarks*
Mine intelligence	Analysis of enemy mining activity may provide exploitable patterns.[8]
Rewards for information	Local civilians may provide useful information on enemy mining activities for a price. Ground speakers and hand-delivered leaflets are more effective than air-dropped leaflets and aerial loud speakers. Although the area covered is considerably smaller, the message is more effective because it is more personal.
Eagle flights or thunder runs	Eagle flights are periodic helicopter overflights; thunder runs are periodic mounted patrols. Conducted at irregular intervals (day or night), they are effective at reducing mine and ambush incidents. Against a severe threat, these patrols should be augmented with stay-behind ambush patrols and snipers. Roads previously cleared should not be considered secure unless constant surveillance has been maintained.
Main supply route (MSR) checkpoints	Security must be an integral part of any successful route-clearance mission. Checkpoints provide 24-hour surveillance of vulnerable stretches of MSR. Aggressive patrolling (mounted and dismounted) and surveillance of an MSR during periods when it is not in use makes it difficult for the enemy to lay mines.
Tactical land clearance	This deprives the enemy of concealment and improves friendly fields of fire. FM 5-164 describes the use of Rome plows and similar equipment.[9]
Road treatment	Mining activities are easier to detect with certain types of road treatment. Paving roads is one of the most effective means to counter enemy mines because holes in asphalt are difficult to dig and easy to identify. Even if an asphalt spreader is used only to put lines of asphalt mix on a road, any disturbance of the pattern is easily recognized and difficult to camouflage at night, when many insurgent mines are laid. Some dust-control treatments (such as diesel/RC-3 mixture, peneprime or partially refined crude oil) also aid mine sweep teams in visual mine detection.[10]
Improvised armor for wheeled vehicles	Sandbags and add-on armor kits reduce casualties. Several countries, including South Africa, have fielded extremely effective mine-resistant vehicles.[11]
Thorough rehearsals	Rehearsals ensure proper unit reaction in the event of enemy contact and/or mine detonation. This is especially important for convoys composed of units that have not worked together before.[12]
Preplanned fire support	Range fans should cover the entire route; if not, arrange to have attack helicopters cover the route.
Avoid predictability	The enemy will find a flaw and exploit it. Many units establish a procedure for mine sweeps and then never deviate from it. While this approach may assure the commander of a thorough, well-controlled sweep, it also gives the enemy the advantage of being able to predict movements. Then he is able to place mines to inflict maximum damage.
Remain dispersed	After a mine incident, establish security and clear the area with a sweep team. Do not cluster around casualties.
Enforce mine discipline	Proper execution of individual tasks minimizes casualties.
Multiple starting points	This allows work to be accomplished in parallel, not in a series.
Unit consistency	Always assign the same team to the same section of road so team members become familiar with local conditions and enemy tactics.
Follow-on neutralization	Mines are marked by the sweep teams and neutralized after the sweep teams have advanced out of the danger area. This technique should only be used if security forces can provide adequate overwatch to the sweep team.
Reserve proofing devices	This allows the sweep to continue uninterrupted if one proofing device is damaged.
Litter-control campaign	Inform road users not to leave metallic trash on the MSR because it may give false positive readings on mine detectors.

speed of mine recons in Somalia, but their detection rate against US-emplaced unfuzed "control" mines was 100 percent with no positive false alarms.[7]

Sweep rates for various route-clearance techniques are shown in Table 2. Some methods that may decrease vulnerability to mines and increase sweep rates are listed in Table 3.

Conclusion

The maintenance of secure LOC is a critical task that permits other combat operations to be successfully undertaken and sustained. Treating route clearance as an administrative task rather than a combined arms combat operation will often result in failure. Maneuver commanders must allocate sufficient resources and adequately prepare personnel for route clearance to ensure success. Considering the increased likelihood of conducting operations other than war and the vulnerability of LOC in such environments, it is critical that U.S. forces be prepared to effectively execute route-clearance operations.

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References And Endnotes

Note: Except as noted below, all information in this article was extracted from *Vietnam, Lessons Learned, Landmine and Countermine Warfare*, Engineer Agency for Resources Inventories, Washington, D.C., August 1972.

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[1] *After Action Report, Operation Restore Hope*, William Schneck, Belvoir Research, Development & Engineering Center, Fort Belvoir, Virginia, 13 June 1994. Hereafter referred to as "Operation Restore Hope AAR."

[2] For current doctrine, see Field Manual 20-32, *Mine/Countermine Operations*, Chapter 10, 30 September 1992, (with Change 1, 17 August 1994). Collective (unit) skills are found in the Mission Training Plan for the Combat Engineer Platoon (Airborne, Air Assault, Motorized Division and Airborne Corps, ARTEP 5-025-1 1 -MTP, October 1989, pages 5-104 to 5-107. Additional nondoctrinal information is in Sapper Countermine Guide, BRDEC PAM 350-4, November 1990, page 150.

[3] *The United States Army Engineer After Action Report for Operations Desert Shield and Desert Storm*, US Army Engineer School, Fort Leonard Wood, Missouri, July 1993, pages Sustainment-14 to Sustainment-15.

[4] *Operation Restore Hope AAR*, page 22. Radio-controlled mines, although relatively rare, may require electronic warfare assets to effectively counter them.

[5] FM 5-34, *Engineer Field Data*, September 1987, pages 2-5.

[6] This technique is more closely related to the deliberate sweep described in Field Manual 20-32, *Mine/Countermine Operations*, September 1992, page 10-1, than the technique that was called a deliberate sweep in Vietnam, as described in this article. The thoroughness of the hasty sweep described in the current Field Manual 20-32 falls between the hasty sweep and mine recon of the Vietnam War.

[7] *Detection of Land Mines in Somalia Using Commercial Infrared Cameras (U)*, AMSEL-NV-TR-0117, by Harry N. Hambric, August 1994.

[8] Training Circular 5-31, *Viet Cong Boobytraps, Mines and Mine Warfare Techniques*, Headquarters, Department of the Army, Washington, D.C., 18 December 1969, pages 6-10.

[9] Field Manual 5-164, *Tactical Land Clearing*, August 1974.

[10] Basic Report, Volume 1, *Study and Evaluation of Countermine Activities (SECMA)*, Army Concept Evaluation Team in Vietnam, 26 September 1968, page 19, Annex C and Technical Manual 5-337, *Paving and Surfacing Operations*, February 1966, page 72.

[11] *The Development of Mine Resistant Vehicles*, by William Schneck, Proceedings of the Fifth Annual TACOM Combat Vehicle Survivability Symposium (U), Volume 1. April 1994, pages 83 to 101.

[12] *Convoy Ambush on Highway 1*, by John Albright, Seven Firefights in Vietnam, Center of Military History, US Army, 11 October 1984, Washington, D.C., pages 41-58.

Engineers Give Fort Dix a Facelift

By Lieutenant Colonel Philip J. Grande, Lieutenant Colonel Paul Malmrose and Major John Waltz

Faced with deactivation as an active duty post, Fort Dix, New Jersey, realized they needed new training facilities for Reserve Component (RC) units and upgrades to the post's infrastructure. With little funding available, the Directorate of Public Works (DPW) had to develop an innovative and cost-effective plan to accomplish these improvements. In 1993, the DPW and the 411th Engineer Brigade, an Army Reserve unit in Brooklyn, New York, assembled a team of active, reserve, and civilian personnel to develop and implement a program to provide a "facelift" to Fort Dix.

The Directorate of Plans, Training and Mobilization at Fort Dix set the following priorities for the training facilities:

- Leadership reaction course
- Enemy prisoner of war (EPW) compound
- M1A1 tank range and helicopter bore-sighting facility
- Artillery observation tower

Upgrades to the infrastructure included replacements for a—

- Timber trestle bridge
- Supply warehouse

Most of the work on the projects was accomplished during Army Reserve weekend inactive duty training (IDT) or the 2-week annual training (AT). To meet the challenges posed by tight work schedules and a continually changing workforce, the reservists used pre-engineered or prefabricated structures to speed up construction. DPW civilian personnel completed preparatory tasks, and the 411th Engineer Brigade provided plans, design, coordination, and construction management. This cooperative effort resulted in a successful troop construction program for FY94.

Leadership Reaction Course

A leadership reaction course consisting of 16 stations was needed by April to provide training for Reserve Officer Training Corps (ROTC) cadets. The 469th Engineer Battalion from Jersey City, New Jersey, began construction in September

1993, performing most of the work during IDT. They modified plans for successful leadership reaction courses at other installations so they could situate stations to avoid removing large trees whenever possible, thus minimizing disturbance to the environment. Detailed planning by the battalion and the brigade staff enabled the 469th to rotate its elements to maximize the use of IDT. To add to the challenges, New Jersey suffered its worst winter in years. Then, in February 1994, the battalion was notified that it would be inactivated by September. Because of unit pride and determination, the soldiers worked through the winter, prefabricating large items indoors and assembling the stations on-site as the weather improved. The stations were built primarily of timber and steel with concrete footings. Each station was enclosed on three sides to prevent observation by soldiers being tested in other stations. When the inactivation process reduced personnel available for the project, civilian personnel helped complete the course in time for cadet training. The total project cost about $32,000.

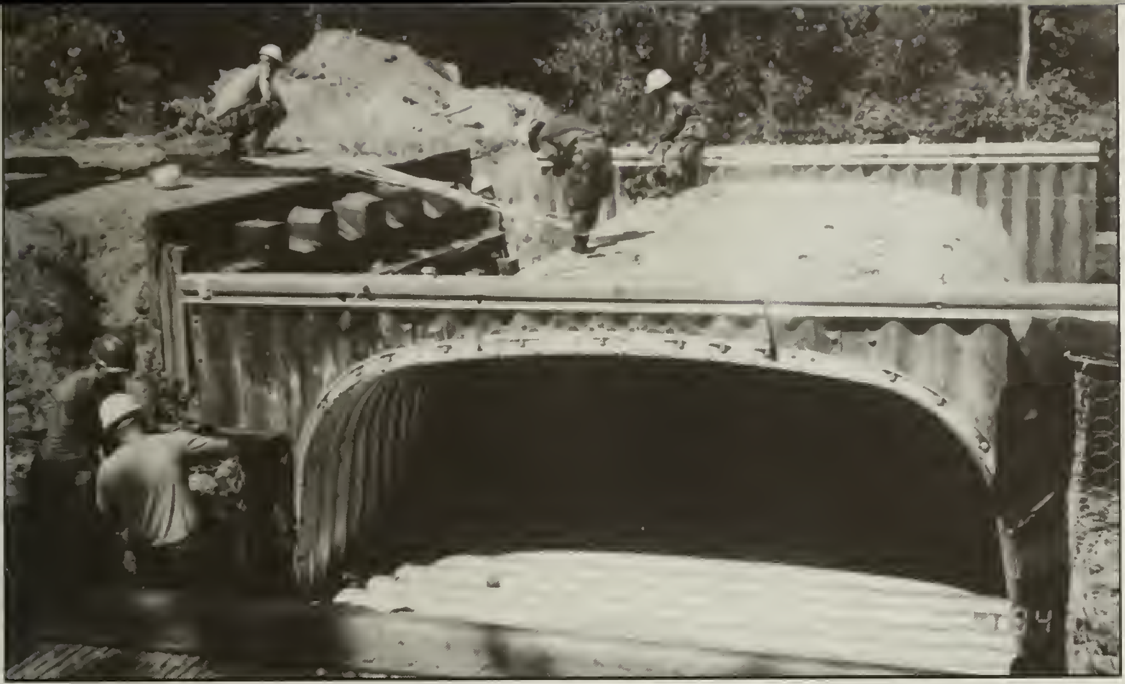
EPW Compound

The 104th Engineer Battalion, a National Guard unit from Teaneck, New Jersey, constructed the EPW compound. Because military police (MP) units needed this compound to meet their training requirements, the planning team met with several MP units to determine their specific needs. Then the 411th Engineer Brigade designed a 250-man holding facility consisting of concertina fences, timber gates, and timber guard towers. Using experience gained from constructing similar compounds during Operation Desert Shield/Storm, the 104th built the facility during their AT, using about 5,000 hours of troop labor. Materials for the project cost about $16,000.

M1A1 Tank Range

At Fort Dix, Tank Range 85 had moving targets for armored vehicles, but no range met the Table VII standards that allowed M1 Abrams tanks to fire their main guns, either while stationary or moving. Plans called for two 475-meter tank roads for gun-stabilization runs, five M1 tank battle positions, and two helicopter landing zones. The 411th Engineer Brigade provided the design and construction management while the 463rd Engineer Battalion, an Army reserve unit from Wheeling, West Virginia, constructed the range. To facilitate test firing an M1 tank in April 1994, civilian personnel constructed one stabilization run during the winter. After test firing on this run, it was possible to modify the overall design before the 463rd began construction on the second stabilization run in June. They built tank roads using a base of 4,000 cubic yards of structural fill, then installed a geotextile fabric mat and a 12-inch layer of compacted, well-graded stone aggregate to stabilize the roads. The hull-defilade tank battle positions consisted of a concrete base requiring 4.5 tons of reinforcing steel and 90 cubic yards of concrete. For each battle position, the 463rd installed a

Members of the 411th Engineer Brigade construct a K-Span warehouse.


Soldiers install a corrugated aluminum plate box culvert.

4-foot-10-inch-high frontal barrier using gabion caging filled with 160 tons of rock. They added two helicopter landing zones to Range 85 to provide areas for bore sighting, weapons loading, and emergency landings in case of "cook offs" (misfired rounds or weapons malfunction). One loading zone required 17 cubic yards of reinforced concrete on a 12-inch compacted-stone base; the other had a stabilized compacted-stone pad consisting of 3,400 cubic yards of multiple-graded stone aggregate and structural fill.

The upgraded range permits tank gunnery qualifications, which saves travel time and expenses for all armored units in and around Fort Dix. The range also serves as a model for future range upgrades. The project required approximately 5,000 man-hours of military labor (three companies operating 24 hours a day for six days during the June 1994 AT) and 3,000 hours of construction equipment time. Cost of materials was about $90,000.

Artillery Observation Tower

Replacing the superstructure on top of a 20-foot-high steel artillery observation tower on Range 59A presented several challenges for the 463rd Engineer Battalion. Constructed before World War II, the tower superstructure had deteriorated to a point where it was structurally unsafe. Before replacing the old superstructure, the original timber framing had to be demolished. Because of the heights involved, safety was a prime concern. The 463rd constructed the new 90-square-foot, two-room structure at ground level then used a 25-ton crane to lift it into position atop the steel tower.

Although the new structure is a reproduction of the original design, it is much improved. Hollow doors were replaced with solid-core units with commercial locks, drafty wood windows were replaced with aluminum ones, and the original masonite interior was replaced with plywood. The tower now provides a safe observation point for adjusting indirect artillery firing at the highest point on the eastern edge of the Fort Dix impact area. The project required approximately 860 man-hours of military labor, and 200 hours for construction equipment. The materials cost about $13,000.

Bridge Replacement

Replacing a deteriorated timber-trestle bridge provided the 411th engineers with an interesting challenge—constructing a replacement structure while maintaining traffic and controlling a streamflow of about 4 million gallons of water per day. A team of DPW civilians and Army reservists met the challenge. After carefully considering construction materials, methodology, and road and bridge alignment, they selected a low-profile corrugated aluminum plate box culvert designed to carry an M1A1 tank weighing about 72 tons. The culvert could be installed quickly and would correct the 3- to 4-foot misalignment of the road with the timber bridge without removing the existing concrete abutments. Civilian personnel installed an armored vehicle-launched bridge (AVLB) adjacent to the existing span to maintain traffic while they demolished the superstructure of the existing bridge and constructed the new culvert. To control streamflow, the team lowered an upstream impounded lake to hold a four-day supply of water. The lake was lowered 3 1/2 feet with five 10-inch PVC siphons, then the spillway was raised an additional 18 inches with plywood and structural lumber. The 306th Engineer Company of Amityville, New York, constructed the culvert, which had a 13-foot-10-inch span, a 5-foot-5-inch rise, and a 22-foot-6-inch length, and placed it on a prepared crushed-stone base in the streambed. They used gabion wire baskets filled with 9-inch-plus rock for wing walls on both sides, up- and downstream. They placed a 12-inch reinforced concrete slab over compacted structural fill to provide a wearing surface for tracked vehicles and to prevent damage to the culvert. The entire project took less than 10 days to complete, with 2,700 man-hours of military labor and 220 hours of military equipment time. The cost of materials was about $24,000.

Warehouse Replacement

During the final project at Fort Dix, a team of active duty Army personnel, Army reservists, and civilian personnel replaced a warehouse with a high-arched steel structure. The original timber warehouse, built about 1917, was near collapse. Based on their experiences in Saudi Arabia during Desert Storm, the 411th Engineer Brigade recommended a K-Span building for the warehouse. The 63-foot-wide, 22-foot-high, 198-foot-long structure was manufactured on-site using a trailer-mounted automatic building machine (ABM) and a seaming machine. The ABM shaped the steel coil sheets into 12-inch channels then curved them to the proper dimensions. Using the seaming machine, several arched panels were fastened together and lifted into place by a 25-ton crane. The active duty Army at Fort Stewart, Georgia, loaned the arch-building machine to the DPW at Fort Dix. The 411th Engineer Brigade provided the design, specifications, and construction management. The 306th Engineer Company supplied labor to construct the building during its FY94 AT. The Fort Dix DPW demolished the existing warehouse, repaired and top coated the existing concrete slab foundation, and provided contracting services. Global Steel, Incorporated, provided materials, foundation design, and technical assistance and training. The arched steel structure and the construction team concept made it possible to complete the project for about $185,000.

Lessons Learned

Based on the experiences at Fort Dix, the critical elements for developing a successful troop construction team are planning and effective communications. The following lessons will help units tasked to perform similar projects:

- Develop a cooperative spirit among all participants. Civilians must realize that reservists only work one weekend per month, which requires long lead times. Reservists must realize that civilians are not available on weekends, which requires planning during the week. For the Fort Dix projects, civilians worked on weekends and reservists took time off from their civilian jobs to work on weekdays.
- Provide a reservist to coordinate with the post during weekdays. At Fort Dix, two 3-month tours were provided for reserve officers to coordinate the projects.
- Assign civilians who are also reservists to projects; they will understand how reserves function.
- Use the team concept to select projects having a high priority for the base but which can be completed by reservists during their 2-week AT.
- Use pre-engineered or prefabricated products that can be installed quickly and cost effectively. Use manufacturers' representatives to train work crews to install the product.
- Make detailed plans. For these projects, design engineers met with the constructing units to review and develop bills of materials and critical path schedules. Have constructing units view video tapes of pre-engineered or prefabricated products being assembled so they will understand installation requirements.
- Arrange for teams to work on alternating weekends to maximize construction time during IDT.
- Prefabricate structures indoors during the winter to effectively use training time during inclement weather.
- Develop a working relationship with the contracting office at the base. For the Fort Dix projects, the design engineer met with contracting personnel to explain project requirements and to learn the appropriate procedures for developing specifications and contracts for government procurement.

Summary

The troop construction program at Fort Dix provided many benefits:

- Major projects were completed successfully at minimal cost with an Army engineer team of active duty, Reserve, National Guard, and civilian personnel.
- Reliable facilities were completed quickly and cost effectively with pre-engineered and prefabricated structures.
- Projects worth more than $1,000,000 (civilian contractor equivalent cost) were completed for about $360,000 using troop construction (see table, page 57).

Savings To Fort Dix Through Troop Construction

Project	Estimated Civilian Contractor Cost	* Actual Cost Using Troops (rounded)	Estimated Savings
Leadership Reaction Course	$110,000	$ 32,000	$ 78,000
EPW Compound	70,000	16,000	54,000
M1A1 Tank Range	290,000	90,000	200,000
Artillery Observation Tower	35,000	13,000	22,000
Bridge Replacement	75,000	24,000	51,000
Warehouse Replacement	** 450,000	** 185,000	** 265,000
TOTALS	$1,030,000	$360,000	$670,000

*** Since troop labor is paid from training funds, Fort Dix only had to pay for materials, rentals, and outside services from project funds.**

**** Includes future electrical and fire-suppression system costs.**

This high-payoff and innovative team concept resulted in quality construction on training and infrastructure facilities for the installation. The project also provided an outstanding training opportunity for Reserve and National Guard engineers.

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Lieutenant Colonel Malmrose is a construction manager, 411th Engineer Brigade. An environmental engineer, he holds a bachelor's degree from Rensselaer Polytechnic Institute and is a registered professional engineer in NewYork.

Major Waltz is a project officer for design and construction management, 411th Engineer Brigade. He holds a master's degree from New York University and is a registered professional engineer in New York.

(Lessons Learned, continued from page 45)

The study results on page 45 can predict the performance of a unit on the battlefield. If you don't see at least a fair performance of these functions in your unit, you're probably headed for disaster! If you are part of a combined arms team and you see these functions performed well, your unit is likely to win the battle.

Conclusion

There it is—the answer to how and why Army combined arms maneuver units' planning succeeds or fails to synchronize engineer planning and execution during combat operations. Although successful performance of all the tasks and functions is desired, it does not guarantee success. In some of the battles included in this study, the combined arms teams did everything correctly and still lost the battle.

The unanswered question is: Knowing that these tasks/functions lead to success on the battlefield, why don't engineers perform them better? "Time" may be the best answer. With everything that combined arms teams must do during a battle, some tasks fall to a low priority. Based on the key findings of this analysis, we strongly recommend that commanders and staff officers of all combined arms team elements use the study results as landmarks on the path to success on the future battlefield.

Reference:

[1]Thomas J. Thompson, Robert J. Pleban, and Patrick J. Valentine (1991). *Battle Staff Training and Synchronization: The Integration of Functions Critical to Combat Operations*, page 194.

Captain Whitney Wolf serves as an operations research systems analyst for the Directorate of Evaluation and Standardization, U.S. Army Engineer School. He holds a bachelor's degree in construction engineering from Missouri Western State College and is a graduate of the Combined Arms Staff Services School and the Operations Research Systems Analysis Course.

SAWE/MILES II:

Providing Realistic Battle Effects for Today's Training

By Sergeant First Class Todd A. Petersen

SAWE/MILES II, (Simulated Area Weapons Effects Multiple Integrated Laser Engagement System), the next generation tactical engagement simulation system, provides force-on-force field training for maneuver units. Building on 10 years' experience with the field-proven MILES system, it integrates area weapons with indirect-fire and direct-fire simulations so that maneuver units can train with weapons systems they will use in battle. The system allows unlimited player participation and position-correlated event data collection.

The SAWE portion combines a new Global Positioning System (GPS)-based area weapons/indirect-fire simulation with MILES II, a laser-based direct-fire simulation. The new system incorporates simulation fidelity enhancements and built-in instrumented data-collection features. The satellite-based GPS provides individual player positioning and adds flexibility in tactical engagement simulation.

The SAWE/MILES II player equipment employs designed-in solutions for all tactical training, from small units at home stations to the high-tech combat training centers (CTCs). It addresses tactical training requirement solutions for soldiers through aircraft and is fully compatible with the "old" MILES system. The Combat Maneuver Training Center, Hoenfels, Germany, currently uses SAWE/MILES II. The National Training Center, Fort Erwin, and the Joint Readiness Training Center, Fort Polk, will begin using it this year.

SAWE/MILES II includes the following components:

The ***Mission Control Station*** (MCS) provides a central user and fire-mission interface that allows both opposing forces to play. The MCS provides simulation fidelity from individual tube to battalion-level missions, from 60mm mortar to MLRS weapons, and NBC effects.

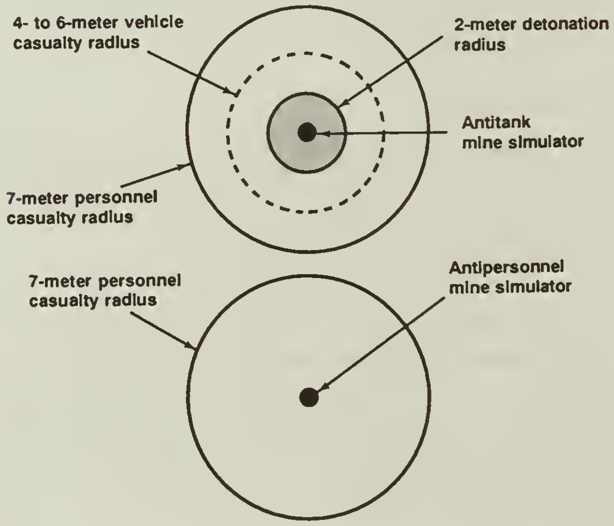
The ***Radio Telemetry Network*** broadcasts fire missions to all participants; it accommodates more than 100 missions per minute.

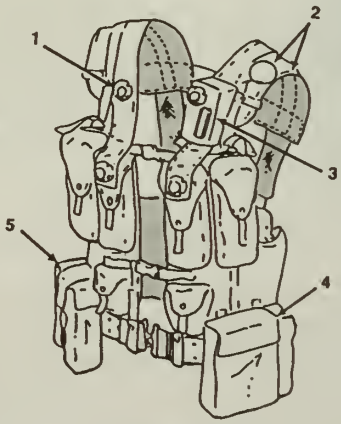
The ***SAWE/MILES II Player Units*** incorporate mine-effects simulation with deployable mine simulations; they enforce chemical assessments based on the proper use of chemical masks. The player units are fully programmable and allow for enhancements and upgrades.

The ***Soldier System*** includes—

- Integrated harness assemblies
- Low-power electronics with a long-life battery
- Chemical mask interface

SAWE/MILES II MES Casualty Areas

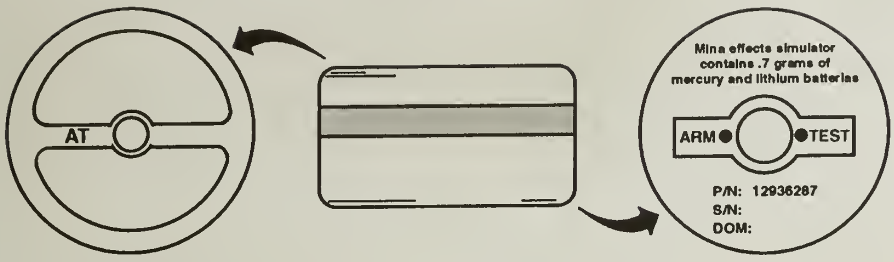

4- to 6-meter vehicle casualty radius
2-meter detonation radius
Antitank mine simulator
7-meter personnel casualty radius
7-meter personnel casualty radius
Antipersonnel mine simulator



Torso Vest

1. Laser detectors
2. GPS antenna (MCS antenna not shown)
3. Display console
4. SAWE electronics module and MES receiver
5. SAWE battery

SAWE/MILES II Mine Effects Simulator


AT
Mine effects simulator contains .7 grams of mercury and lithium batteries
ARM
TEST
P/N: 12936287
S/N:
DOM:

The ***Vehicle System*** has the following features:

- One console that is common to all vehicle types
- Ammunition-dependent probability-of-kill for direct-fire weapons
- Multilevel kills: firepower, mobility, communication, and catastrophic
- Synthesized voice cues, which eliminate the need for the "casualty card"
- Vehicle power interface

Common features include:

- Six-channel GPS
- Programmable weapons simulation
- Instrumentation data-collection interface and internal data storage
- Direct-fire, indirect-fire, and mine-effects simulation
- Direct fire MILES player identification
- Chemical alarm simulation
- Built-in test
- MILES capability

Soldiers can use a reactive training mine, called the ***Mine Effects Simulator (MES)***, with SAWE/MILES II. The MES is designed to replicate in size, shape, weight, and capability the M74/M75 antipersonnel/antitank mine. It emits a radio frequency when activated, which sets off the SAWE portion of the new gear and assesses the appropriate casualties.

Now, for the first time, engineers have a system that cannot be ignored by soldiers during training exercises. No longer will engineers have to watch an armored unit "find" a minefield and then drive through it without "casualties."

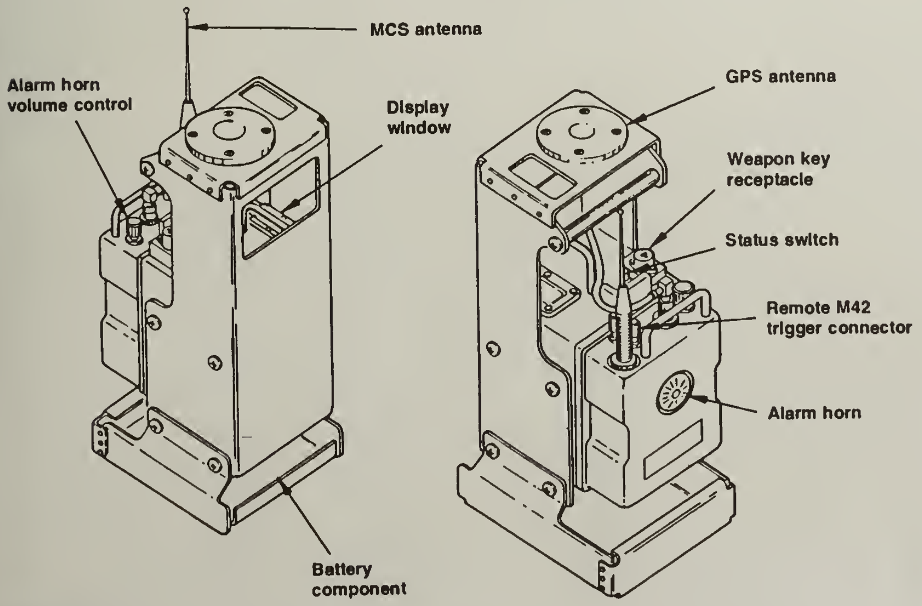
Together, the SAWE/MILES II and the MES systems provide a 21st century battlefield simulation that facilitates training, to standard, for all players in the combined arms force. The effects provided by these systems realistically demonstrate the lethality of weapons employed in war. They also show commanders and soldiers the effectiveness of using proper doctrine and tactics.

Development and testing of SAWE/MILES II was an extensive and time-consuming effort that involved personnel at the Artillery, Chemical, Infantry, and Engineer Schools, as well as the Army Training and Simulation Command. Thanks to the efforts of these members of the combined arms team, the Army now has an improved training method to realistically simulate battle effects during combined arms exercises.

Sergeant First Class Todd Petersen is a senior training developer/writer, Directorate of Training, at the Engineer School. Previous assignments include platoon sergeant, A Company, 20th Engineer Battalion, and drill sergeant, A Company, 3-10 Infantry. SFC Petersen is a graduate of the Drill Sergeant and Air Assault Schools.

All artwork courtesy LORAL

Chemical Agent Alarm Simulator Controls and Indicators



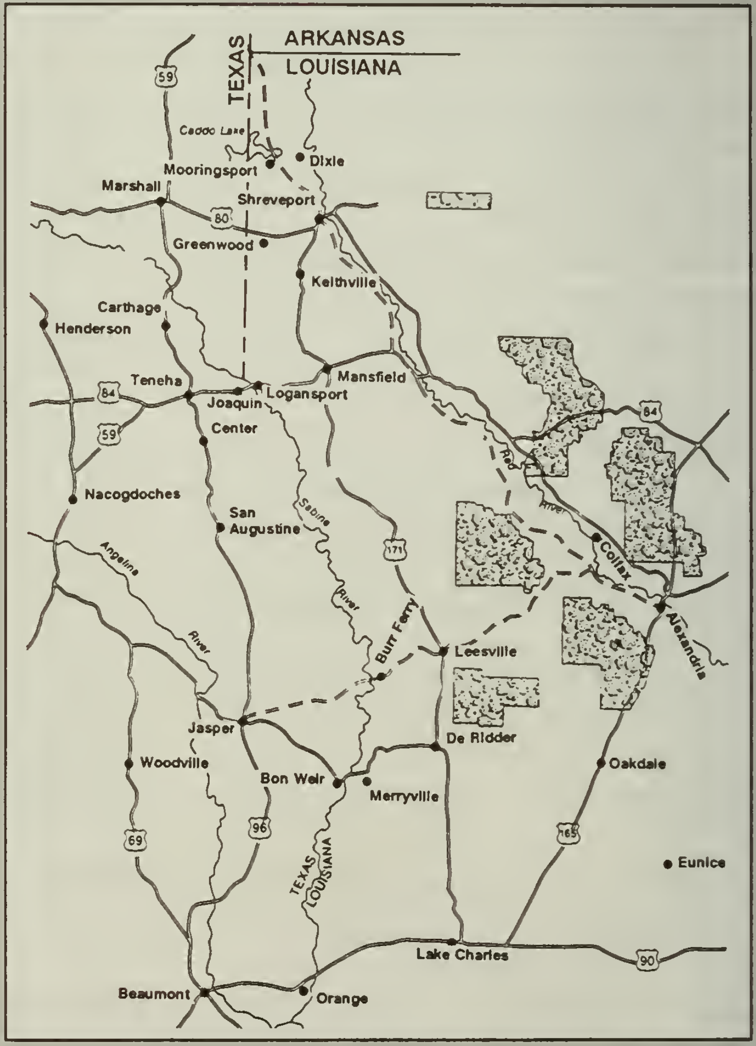
Past in Review

1941 Louisiana Maneuvers

By Dr. James W. Dunn

The U.S. Army conducted the most extensive maneuvers in its history when more than 400,000 men moved into Louisiana in the fall of 1941 to participate in a two-phased exercise called "The Louisiana Maneuvers." Under the direction of Lieutenant General Lesley J. McNair, the maneuvers were an extension and testing of training for a mobilizing army of Regulars, federalized National Guard and Reserves, and new inductees. Chief of Staff George C. Marshall saw the maneuvers as an opportunity to make and correct mistakes under near-battle conditions. Influenced by the speed and thoroughness of the German defeat of France in the summer of 1940, Marshall realized that the U.S. Army was on the brink of a war of movement, in which engineers would play a vital role.

The Plan. If the maneuvers were to test the Army's mobility, the engineers would have to tame the Louisiana terrain. The maneuver area of 30,000 square miles stretched from Shreveport south to Lake Charles and from Jasper, Texas, east to the Mississippi River. Three large rivers, the Sabine, the Cane, and the Red, dominated the area; and the low, flat, and swampy terrain afforded little cross-country movement for mechanized units. The roads were good but were muddy because it was hurricane season, and storms influenced both maneuver phases. In the south, the Kisatchie National Forest provided good defensive terrain but was a definite impediment to mechanized movement.



Lieutenant General Ben Lear's Red (Second) Army was one of two involved in the maneuvers. It included the VII Corps of one Regular and two National Guard infantry divisions, the I Armored Corps of the 2nd Cavalry Division, and two Regular armored divisions; two infantry divisions were in reserve. The other army, Lieutenant General Walter Krueger's Blue (Third) Army, consisted of the IV, V, and VIII Corps; it had one Regular and eight National Guard infantry divisions, with the 1st Cavalry Division in reserve. Each Regular division (configured in the new triangular concept) had an engineer battalion, while the National Guard divisions (configured in the old square concept) had engineer regiments. The corps had engineer regiments, and there were two engineer regiments plus heavy ponton battalions and light ponton companies at army level. The newly organized 21st Engineer Aviation Regiment, with C Company, 81st Engineer Aviation Battalion attached, supported both armies. All of the engineer elements were at half strength due to 20 years of meager budgets and skeletonized units.

Phase I. For Phase I, when "war" was declared at 0500 on 15 September, Lear planned to attack south across the Red River, with the

The 2nd Infantry Division crosses a river on an engineer-built footbridge.

armored corps leading. It was to sweep west to the Sabine River and then turn south, prepared to launch a decisive attack against the Blue Army's left flank. Krueger wanted to attack northeast, with three corps abreast, and attempt to trap Lear against the Red River. The stage was set for a massive meeting engagement.

Engineers were among the first to arrive in the maneuver area. Before the declaration of war, the 21st Engineers turned the rutted and swampy Lake Charles Airport into a usable field for the Blue air component and extended the runways at Monroe Airport for the Red air element. Other engineers established train and truck depots, repaired roads, and strengthened bridges. Red engineers, with the benefit of unhindered air and ground reconnaissance, located forward assembly areas for men and equipment and developed detailed construction plans for bridging the Red River.

At 0500 on 15 September, the I Armored Corps crossed the Red River over fixed bridges while the VII Corps, using engineer-driven assault boats, began to cross in the area of ponton bridge construction. The VII Corps engineer, Lieutenant Colonel Mason J. Young, used the 35th Engineer Regiment, the 85th and 86th Heavy Ponton Battalions, the 76th and 77th Light Ponton Companies, plus one battalion each from the 102nd, 108th, and 110th Engineer Regiments, to build two heavy (25-ton) ponton bridges and one reinforced (20-ton) ponton bridge. Simultaneously, the Red Army engineer, Colonel Jarvis J. Bain, used the 43rd Engineer Regiment to build a standard (10-ton) ponton bridge.

As the Blue Army moved northeast, it came under pressure on its left flank from the forward elements of the Red I Armored Corps. Krueger defended successfully using antitank guns and engineer-constructed obstacles. Although the Red Army was astride the Blue left flank by the end of the day, it had not gained good attack positions.

On the 16th, as the Red VII Corps continued to stream across the ponton bridges and build up on the Blue left flank, Krueger fought to reorient his army to the northwest. He used the 88th Heavy Ponton Battalion, the 75th Light Ponton Company, and the 20th and 151st Engineer Regiments to construct ponton bridges over the Cane River. Then he moved the IV and V Corps over land that engineer intelligence deemed passable to vehicular traffic to gain key terrain in the Kisatchie National Forest. By that evening the reoriented Blue Army directly faced the Red Army all along the line.

The next day Lear continued to press to gain key terrain for his decisive attack on the 18th against the Blue left flank. Krueger blunted these Red movements with the aid of engineer-constructed obstacles while his V Corps attacked and turned the left flank of the Red 6th Infantry Division. By that evening the Blue Army held key defensive terrain on the left and center and was deep into the Red Army's rear area on the right flank.

Because he had to send most of the 1st Armored Division to aid the hard-pressed 6th Infantry Division, Lear could use only part of the I Armored Corps in his main attack on the right. Attacking against the Blue VIII Corps, the depleted armored corps encountered strong defenses of engineer-constructed obstacles covered by antitank guns. By the end of the day, the Red armored corps had failed to gain any of its objectives and left more than 100 vehicles on the battlefield.

The 1st Armored Division, attacking into the Kisatchie National Forest to aid the 6th Infantry Division, encountered numerous engineer-constructed obstacles and became hopelessly snarled along narrow trails. The Blue air force took full advantage of the long traffic jams to inflict heavy casualties on the armored division.

Krueger, having tied down the Red armor, launched a major attack against the exposed Red left flank. As the Blue forces surged forward over engineer-repaired roads, Lear began to withdraw to better defensive positions. When the Blue offensive became a pursuit on the 19th, General McNair halted Phase I. The Blue Army had won.

Phase II. In Phase II, which began on 24 September, the same two armies competed over the same terrain. The weather continued to be windy and rainy, making roads muddy and nearly impassable. For this phase, the 2nd Armored Division moved to the Blue Army, and two antitank groups transferred to the Red Army as compensation. The engineer elements of both armies were basically configured as they had been in the initial phase.

Krueger, with a mission to seize Shreveport, planned to advance north between the Red and the Sabine Rivers, fix the Red Army with his infantry divisions, and finish it with a provisional armored corps of the 2nd Armored, the motorized 2nd Infantry, and the 1st Cavalry Divisions. He would need a major engineer effort to speedily cross the numerous rivers and creeks in his path north.

Tasked to defend the city until reinforcements arrived on 30 September, Lear planned to use a 100-mile operational area to the south to trade space for time. He established five concentric delay positions, about 15 miles apart, from which his army was to withdraw before being tied down. Lear ordered his engineers to destroy all bridges and culverts and not to let any intact bridge fall into the hands of the Blue Army.

At noon on 24 September, the Blue Army, three corps abreast, moved north. By the end of the day, it had reached the first delay position but had not been able to bring the Red Army to battle. Instead, Krueger found the first of more than 900 demolitions Lear's engineers would make during Phase II. The Red engineers blew every railroad bridge and almost every culvert and road bridge in the main battle area. Lear covered these demolitions with delay task forces that significantly interrupted attempts by Blue engineers to make rapid repairs.

Throughout the night and into the next day the Red Army withdrew to the next delay position. Corps engineers emplaced charges, and division engineers blew the bridges after the last Red troops had crossed. Impeded by the Red delay task forces, Blue engineers found it much harder to make repairs than to execute demolitions. By the evening of the 25th, the Blue Army had yet to make contact with the main Red Army. Lear was successfully using the muddy roads, engineer demolitions, and delay task forces to avoid battle and gain time.

Krueger decided to make a wide envelopment of the Red right flank. On the night of 25-26 September, using ponton bridges built by the 87th Heavy Ponton Battalion, the 71st Light Ponton Company, and the 42nd and 46th Engineer Regiments, Krueger sent his provisional armored corps west across the Sabine River with orders to move into the Red Army's rear. Successful, the Blue armored corps was beyond the Red second delay line and in position to threaten Shreveport by the evening of the 26th.

It took all of the next day for Blue engineers to span the rain-swollen Sabine River, which halted the motorized 2nd Infantry Division's drive. However, while the 2nd Armored Division used fixed bridges to move north of Shreveport and threaten the city from that direction, the main Blue force finally contacted the Red Army and brought it to battle.

The next morning, the Blue VIII Corps drove a bulge in the main Red defense line as the motorized 2nd Infantry crossed the Sabine River. Using the now-completed ponton bridges, foot bridges, and ferries, they attacked the exposed Red right flank. With the 2nd Armored Division poised to attack into the northern outskirts of Shreveport, General McNair halted Phase II at 1700 on 28 September. Once again Blue had won.

Assessment. General McNair called the Louisiana Maneuvers "The Battle of the Bridges." The engineers demonstrated the decisive influence that destroyed bridges could have in a war of mobility. In World War II, the destroyed Calumpit bridges allowed General MacArthur an orderly withdrawal into Bataan, and destroyed bridges and culverts delayed Colonel Peiper in the Bulge.

The maneuvers were a realistic test of the engineers' construction capability and proved the need for strong engineer elements in mobility warfare: Either the engineers constructed the bridges and repaired the roads or the maneuver elements couldn't move.

The new aviation engineers proved their worth to the U. S Army Air Force by demonstrating their ability to repair and maintain airfields. Their capability improved during the Carolina Maneuvers, which were held in November 1941. During those maneuvers the 21st Aviation Engineer Regiment, using the new Marston mats, built a 3,000-foot runway in 11 days. By the end of World War II, an engineer aviation battalion could build a B-17-capable, 5,000-foot runway in 72 hours.

The engineers felt the Louisiana Maneuvers tested their ability to build bridges, repair roads, and conduct assault river crossings. They learned some lessons: the need for river-crossing rehearsals, the importance of reconnaissance, and the need to move men and bridging equipment forward during the night. They found some problems: for example, bridge building took too long. The solution was training, and four months of remedial training began immediately. Unfortunately, engineers did not have four months—7 December 1941 was less than three months away.

Additional Reading:

Gabel, Christopher R., *The U.S. Army GHQ Maneuvers of 1941*, U.S. Government Printing Office, 1991.

Dr. James W. Dunn is Chief, Studies and Analysis Division, Office of History, U.S. Army Corps of Engineers, Alexandria, Virginia.

ENGINEER UPDATE

Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

Interservice Training Review Organization (ITRO). Implementation of the ITRO initiative continues, with building modifications, equipment purchases, and personnel assignments on schedule. Some complicated issues, such as class scheduling, are being worked.

Transfer of the Army's carpenter/masonry (MOS 51B) training to the Naval Construction Battalion at Gulfport, Mississippi, occurs in April 1995. Training for plumbers (51K) transfers to the Air Force, at Sheppard AFB, Texas, in June. The next major milestone for Fort Leonard Wood occurs in April and June 1996, when the service-unique portions of the Motor Transport Operator Course (MTOC) from the Air Force and Marine Corps collocate here. The MTOC study will end in September 1996, when consolidated Marine Corps and Army MTOC classes begin at Fort Leonard Wood. POC is Connie Welch, -4111.

Engineer School Reorganization. The U.S. Army Engineer School is reorganizing due to significant funding shortfalls. Effective in July, responsibilities for doctrine and training development, combat development, engineer personnel proponency, and officer training will fall under the Deputy Assistant Commandant's (DAC) office, which will consist of four directorates. The 1st Engineer Brigade will assume responsibility for Advanced Individual Training (AIT) and One Station Unit Training (OSUT).

Faces and spaces, as well as telephone and FAX numbers, will change this summer. We will publish a telephone roster for the new directorates in the next issue of *ENGINEER*. Until then, use the current numbers and we will forward your call. POC is MAJ Moises Perez -6197.

Directorate of Combat Developments (DCD)

Engineers Evaluate New Squad Vehicle. A prototype for a new Combat Engineer Squad Vehicle (CESV) is being evaluated at the Engineer School. The CESV is designed to provide combat engineer squads with a carrier equipped with battlefield protection that will allow them to provide engineer support to front-line forces.

The CESV prototype is designed to eliminate three deficiencies in the current M113A2 vehicle: inadequate payload space under-armor, inferior relative mobility, and insufficient survivability. The vehicle is based on the Mobile Tactical Vehicle Light (MTVL), a larger version of the more powerful M113A3, but has 50 percent more cross-country mobility, which allows it to keep pace with the M1 tank. It also has 30 percent more under-armor space and payload capacity as well as a modular applique armor package capable of defeating 30mm and RPG threats. POC is SFC Morales, -4074.

Multirole Bridge Company Concept Evaluation. The multirole bridge company concept will be evaluated 20-25 July at Fort Chaffee, Arkansas. The 74th Engineer Company (Assault Float Bridge) from Fort Hood, Texas, is the evaluating unit, with support provided from the 62nd Engineer Battalion (Combat Heavy), Fort Hood, and the 586th Engineer Company (Assault Float Bridge, Fort Benning, Georgia. (An article describing the multirole bridge company begins on page 20.) The unit's capability to command, control, and plan all aspects of unit operations will be evaluated by TEXCOM personnel, and the results will determine the structure of Force XXI bridging units.

The 74th, 586th, and 1438th Engineer Companies (Assault Float Bridge) will participate in a major river-crossing exercise being planned by the 363rd Engineer Group, Oklahoma National Guard, on 18 July 1995. POC is Alan Schlie, -4086.

News and Notes

Engineer Museum Additions. Visitors to Fort Leonard Wood are encouraged to visit the Engineer Museum, which now has two galleries. The first is an encyclopedic gallery that displays engineer items, including surveying instruments, demolitions, bridge models, land mines, and weapons. The second is a chronological depiction of engineers through history. This gallery portrays engineers from the Revolutionary period to Operation Desert Storm. The portion of the gallery completed in 1994 ended with the Panama Canal. Exhibits added this year depict World War I trench warfare, a hydroelectric dam built by the Corps of Engineers during the period between world wars, and engineers clearing rubble in a European village during World War II. In the Korean Conflict diorama, engineers are rigging a timber-trestle bridge for demolition, while the Vietnam display features a mine detection, remote-controlled jeep on patrol and a tunnel used to store munitions. The display for each period includes a diorama that is supported by display cases with artifacts and photographs. The museum also maintains restored World War II buildings that reflect the early days at Fort Leonard Wood. POC is Steve Wells, (314) 596-0169.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

Retaining First-Term Soldiers

The future of our Army is in the hands of leadership that has proven itself over more than 20 years. During that time, I have seen our Army shrink from 770K (thousand) in the 1980s to 510K in 1995, and plans are to reduce further—to 495K. As our forces continue to shrink, it is more important than ever that our future (first termers) be retained and afforded the opportunity to serve our nation as it moves into the 21st century. Our retention record is not good: As the Army draws down, the retention rates for engineer first-term and midcareer soldiers are lower than the average retention rate for enlisted soldiers in the Army.

Recently, I had an opportunity to sit down with key personnel involved with maintaining personnel numbers and participate in a process called a "laydown." A personnel laydown is done each quarter during the fiscal year. It encompasses promotions, authorizations, critical shortages, and priority fills for critical positions.

While working on the laydown, I noticed that personnel strengths in the Engineer Corps are dwindling extremely fast since phase II of the Voluntary Separation Incentive, Special Separation Benefit, and early retirement programs were opened to all three engineer career management fields (CMFs) 12, 51, and 81. As the laydown unfolded, I saw a clear and compelling snapshot of the first-term soldiers who chose not to stay in the Army. The retention rates used at the laydown for engineer CMFs follow:

CMF	MOS	1st Termers (Percent)
12	12B	17
	12C	14
	12F	32
51	51B	16
	51K	20
	51R	0
	51M	100
	51T	50
	62E	17
	62F	0
	62G	100
	62J	19
81	81C	0
	81Q	100
	83E	100
	83F	25

In comparison, the average retention rate for first-term soldiers in the Army is 31 percent.

What do young soldiers want? During my travels to units throughout the Engineer Corps, I have asked this question many times. The number one response is: a good, fair, caring, and strong leader. These traits are essential to good leadership, and they set the stage for retaining quality soldiers. Major concerns voiced by our first termers are: too many deployments (Saudi Arabia, Somalia, Haiti), too much field duty, and limited opportunities for continuing education.

Often we look for the senior leadership at the Department of the Army level to give us the means to retain soldiers. Today, we must look beyond the incentives higher headquarters can or may give us. This is not new—we have lived through other periods when there were no re-enlistment bonuses or incentives. We still have an obligation to retain quality soldiers.

In these difficult times we, as leaders, have the challenge to maintain a strong and steady force within the Engineer Corps. We must continue to lead and guide our soldiers as the Army continues to draw down. From squad leader to commander, we must be steadfast in using techniques that will encourage our first-term soldiers to remain in our great Corps and the Army.

There are many ways to encourage quality soldiers to stay with us. In connection with re-enlistment, commanders have the option to grant attendance to military schools, on-duty college courses, and leaves or passes. To reduce expenses, one commander selected first-term soldiers for attendance at the Airborne School and transported them to Fort Benning on a bus. By using a bus, he increased the number of students attending and reduced travel expenses. That commander had retention rates for first-term and midcareer soldiers that averaged from 10 to 20 percent higher than those of other Army units. Another commander's policy for encouraging re-enlistment included a four-day pass and a 30-day exemption from the duty roster.

To improve engineer retention rates, I recommend that you incorporate interesting and challenging situations in field exercises, consider varied approaches in training your soldiers, and explain educational opportunities. Encourage quality soldiers to stay in the Army. Remember, all leaders have an implied task to retain quality soldiers. Leadership of our Corps, we need your help to maintain a combat ready, quality force!

Wolverine

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Engineers and the Environment

Headquarters, Department of the Army
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CLEAR THE WAY

By Major General Joe N. Ballard
Commandant, U.S. Army Engineer School

As I reflect on my tenure as Commandant of the U.S. Army Engineer Center and Commanding General of Fort Leonard Wood, I have never been more impressed with the professionalism and vitality of our Engineer Regiment. At the recent ENFORCE XXI Conference, we demonstrated that the Corps of Engineers is an integral part of the combined arms team and a key contributor to the combat support and combat service support realms. The regiment has clearly demonstrated its lethal capabilities and its versatility to perform operations other than war, often providing humanitarian assistance for those in need. We are genuinely committed to our role as a force multiplier on a global scale, and I'm proud of our regiment's tremendous accomplishments.

Let me explain what is happening at your Engineer Center. As the Army downsizes and restructures, we too are reorganizing. Change is necessary and critical to our growth and development as the Army's cornerstone to learning. We are emerging as a TRADOC Center for Excellence and the Army's premier Force XXI training center, and we continue to focus our resources on three critical areas: training soldiers, developing leaders, and writing doctrine. Bold, new concepts and technology allow us to promote and support the emerging Force XXI with advanced warfighting experiments and the experimental force. We are not just participants in this great endeavor. Engineers are breaching the berm and leading the Army on the journey into the 21st century.

The Corps of Engineers continues to offer unique opportunities for those who desire to be on the cutting edge. The Engineer School has become a tremendous resource to commanders and engineers in the field. We have contributed personnel and expertise for virtually every major Army deployment to complement force projection packages: topographic engineers for the United Nations Protection Forces in the former Yugoslavia; mine experts for the Red Cross' mine-removal efforts worldwide; nation assistance for our continuing presence in Honduras; and a vast array of resources for Uphold Democracy in Haiti (including BG Phil Anderson, our Deputy Commanding General). We will continue to provide this kind of support to both our Army and our sister services. Nowhere else will you be exposed to such great opportunities than at the Engineer Center.

Our continued focus must be on how the Engineer Regiment will develop and modernize over the next 10 years. In the past we let technology drive strategy. Today our strategy drives technology. Part of our modernization is the Classroom XXI initiative, which allows us the use of rapidly evolving technology. Imagine attending the Engineer Officer Advanced Course (EOAC) or Advanced Noncommissioned Officer Course (ANCOC) via distance-learning, while you are deployed around the world. Classroom XXI will ultimately allow us to provide doctrinal tools, simulations, and instructional products to engineer units around the world using a real-time information platform. We must continue to capitalize on new ideas, make improvements, and excel as engineers traditionally have.

Fort Leonard Wood has also led the Army by assuming new roles and missions. We have been designated as TRADOC's agent for integrating environmental considerations into Army training and doctrine (see article on page 2). Implementation of the Interservice Training Organization (ITRO) is well under way, with the Civil/Construction Engineer Study in the execution phase. We have successfully integrated marines, sailors, and airmen into the Fort Leonard Wood training community. The Army's initiative to consolidate schools and installations will continue with the eventual move and consolidation of the U.S. Army Chemical and Military Police Schools at Fort Leonard Wood. These initiatives will change our status from the Center for Engineering to a "Center for Maneuver Support"—with unique capabilities and diverse resources to support the total Army.

As we struggle to balance the many challenges set before us, we are committed to maintaining a robust and capable engineer force. The Engineer Regiment will meet these challenges with strength and courage, as it has met challenges throughout our rich history since 1775. I am reassured in the knowledge that the regiment gains a great leader in Major General Clair F. Gill, who became your new Commandant on 24 June 1995. My best wishes to MG Gill, members of the Fort Leonard Wood community, and the entire Engineer Regiment. Let us try! ESSAYONS!

Engineer

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UNITED STATES ARMY ENGINEER CENTER AND FORT LEONARD WOOD

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00493

Front cover photo: *A mechanic prepares for an annual service on an Army motor vehicle. He has ensured that environmental protection devices, such as drip-pans filled with absorbant material, are in place to catch potential spills. Photo by Jim Anderson*

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Soldiers and the Environment:

Integrating Environmental Considerations Into Training and Doctrine

By Major David Neeley and Captain Richard Heitkamp

A dramatic change is taking place across the country. The beliefs and values of the nation are turning green—not OD green but environmental green. The changes are visible in trends such as local recycling programs, public-health consciousness, consumer preferences, and tough new environmental laws. The term "environmentally safe" has become the new buzzword for product marketing. U.S. citizens have developed an environmental ethic that is reflected as a national value. As a logical extension of this ethic, the American people require their Army to protect the increasingly fragile and vulnerable natural environment—in training; in operations other than war; and, to the extent feasible, in combat.

For years, the belief within the Department of Defense and private industry was that nature would take care of itself. This belief, in conjunction with the overriding requirements for two world wars, numerous armed conflicts, and the ever-persistent threat of communism, resulted in the testing, development, and production of hazardous substances.

In the past, we paid little attention to how military operations and facilities affected the environment. We now realize that water and air pollution, training area abuse, and mismanagement of hazardous wastes at Army installations represent very real costs, in terms of lost training areas, land reclamation, state and federal noncompliance fines, and negative public opinion. All of these detractors contribute to decreased training readiness.

The events that led to the Army's environmental program and a capstone picture of TRADOC's integration strategy are described in this article. It explains the Engineer School's role and briefly discusses training products currently available. A future article will highlight how this program will affect junior officers and NCOs and the products

Using an attached brush-hose, a soldier washes equipment in a sink designed to trap hazardous waste material.

Photo by Jim Anderson

This waste fuel container houses hazardous waste material at Fort Leonard Wood.

leveloped to guide them through their environnental challenges.

Commander's Intent

The U.S. Army Environmental Strategy Into the 21st Century, the Army's concept for environnental excellence, was signed by the Secretary and he Chief of Staff of the Army in November 1992. 'he cover letter states:

> *Leadership is the key to success. Each of you in the chain of command is responsible for ensuring that the U.S. Army's environmental strategy is implemented and that environmental stewardship is an integral part of everything you do.*

The strategy provides policy and objectives in the arious areas of environmental stewardship as well s a vision for the future. It also identifies six critial elements for success. Four of these elements prode direction pertinent to doctrine and training and re discussed in this article:

- Commit the chain of command.
- Organize for success.
- Spread the environmental ethic.
- Train and educate the force.

Commit the Chain of Command. Guidance om the senior leadership is clear and sufficient. ne Chief of Staff has committed the chain of comand to this mission.

An analogy can be made to the Army safety proam. The success of the safety program, as with the vironmental program, hinges on the commitment of e chain of command. Safety briefings did not solve e Army's safety problems. The number of safetylated incidents did not decrease until safety became commander's program and was integrated into the way we do business. And, to decrease the number of environmental detractors, we must integrate environmental awareness into the way we do business.

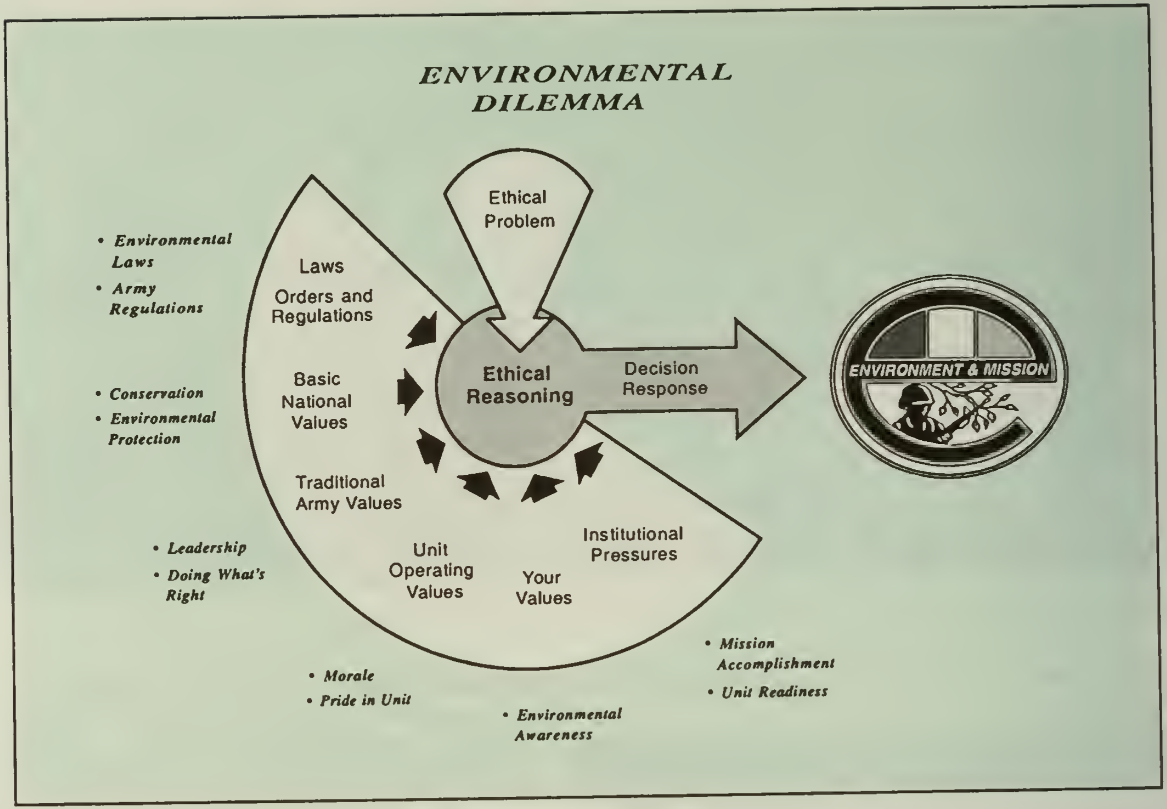
Organize for Success. In 1993, TRADOC designated the U.S. Army Engineer School as the executive agent "for the development and integration of environmental doctrine and training as they apply to tactical units and the Army in the field." The Engineer School coordinated with DA-level environmental staff, TRADOC, and all other service schools to outline a plan for standardized environmental task-based training and doctrine. The resulting TRADOC Environmental Action Plan delineated five steps:

- Establish procedures for incorporating environmental protection and enhancement into Army doctrine.
- Determine requirements for environmental training programs.
- Determine procedures for conducting individual and collective environmental task analysis.
- Determine resources needed to implement the plan.
- Establish milestones.

As TRADOC's executive agent, the Engineer School's mission is to take the action plan and determine the what, where, when, and how soldiers will be trained.

- What (doctrine and specific tasks).
- Where (resident, nonresident, unit sustainment).
- When (level of military education).
- How (type of instruction).

Spread the Environmental Ethic. Field Manual (FM) 22-100, *Military Leadership*, defines ethics as "principles or standards that guide professionals to do the moral or right thing which should be done."



Stewardship is a key element of the Army's environmental ethic. Our Army is charged with protecting and defending the nation, to include safeguarding the environment. In addition, the Army has been entrusted with large land areas and many other resources. The American people expect the Army to exercise good judgment in the use and management of those resources; they expect the Army to be a good steward of the assets entrusted to it.

Environmental stewardship can be achieved only if natural and cultural resource concerns are integrated into the Army decision-making process. Army operations and strategies must include these concerns from the outset so that environmental issues are identified and resolved quickly.

FM 22-100 describes an ethical decision-making process to assist leaders in identifying courses of action that will result in the greatest moral good. All soldiers are taught ethical decision making; the goal is to link environmental stewardship to this process.The model above, the core of which comes from FM 22-100, illustrates that linkage. If environmental considerations are superimposed, the model offers resolution of an environmental dilemma. For example, a leader may consider digging a fighting position near the habitat of a protected species or a soldier may consider dumping waste oil on the ground rather than taking it to an approved collection site. In both cases, the individual weighs the factors represented in the above model. By making environmental ethics a key part of each factor, soldiers will be prepared to achieve an ethical solution that results in environmental stewardship. This issue's Engineer Problem/Solution provides a detailed example (see page 24).

Train and Educate the Force. This imperative is the thrust of the environmental program. In developing a strategy to accomplish this element, the Engineer School looked at both "quick fixes" and long-range remedies. Since training initiatives take several years to produce and implement, they are not quick fixes but serve as immediate environmental guidance until doctrine can be influenced, written, revised, and published.

Doctrinal Integration

Environmental issues play an ever-increasing role on the battlefield, and they are becoming even more significant in conducting operations othe than war. Army battalions now face an incredible mix of operational requirements. Recent deployments have placed small units and junior leaders in critical situations where there are no rules and personal judgment is the only guide. For these reasons, the Army must provide environmental guidance in every level of doctrine.

In the same way that the Army ensures that its commanders are not distracted from their battlefiel duties by the Hague and Geneva Conventions, it must train them to abide by international laws pertaining to environmental protection on the battlefields of the 21st century.

The strategic end state may include leaving behind improved environmental conditions or at least minimizing the environmental impact of the mission, especially for operations other than war. For strategic reasons, therefore, the Army must be capable of operating with minimal environmental impacts.

Capstone Integration

The Army published an environmental strategy in 1992, but it did not connect environmental requirements in garrison with those in operational doctrine. To make this critical connection, the Engineer School developed a White Paper titled *Environmental Considerations in Army Operational Doctrine*, which was distributed Armywide for comments. Based on the input received, we will rewrite it as doctrinal guidance for the Army's service schools and doctrine developers. Information in the White Paper eventually will be included in the Army's capstone doctrine manuals.

Army operational doctrine is comprehensive. It integrates hundreds of subjects into a tightly crafted collection of writings that provides guidance to soldiers at every level. Mapping the requirements of the Army's environmental strategy into operational doctrine will entail a gradual process of introducing concepts and norms into keystone and capstone doctrine manuals, while simultaneously developing specific requirements in proponent publications.

To fully integrate environmental considerations into Army planning, training, and operations, they must be incorporated into capstone field manuals at the appropriate levels. The manuals will drive subordinate doctrine, provide the impetus for training and professional education, and begin the long-term process of preparing for the environmental requirements of the 21st century.

FM 100-5, Operations. This keystone operational doctrine underpins all of the Army's doctrine, training, leader development, organization, materiel, and soldier concerns. Environmental values and considerations should be included in the view of war, he strategic context, the training and readiness challenge, operations other than war, and the physical dimension of combat.

FM 100-1, The Army. Definitions of the Army environmental ethic and environmental considerations belong in this source book for strategic doctrine.

FM 22-100, Military Leadership. This manual hould discuss the environmental component of ethi- al leadership.

FM 25-100, Training the Force and FM 25-101, Training the Force: Battle Focus Training. The Army's training function is directly affected by envi- onmental factors. The training management cycle hould include segments on land and endangered pecies management, range restrictions, training rea carrying capacity, and noise.

FM 100-10, Combat Service Support. Supply, maintenance, and field service-support activities gen- rate large quantities of waste. Petroleum, oil, and ubricant storage and distribution systems are specially likely to cause environmental problems. ogistical planning includes many aspects of environ- ental operations such as health service support nd waste disposal.

FM 101-5, Staff Organizations and Operations. The National Environmental Policy Act (NEPA) must be incorporated into the Army's decision-making process. Almost all staff elements have some environmental planning and oversight responsibilities; these must be listed and their environmental functions integrated.

Doctrine for the Small-Unit Leader

While accessing capstone doctrine is vital to fully integrate environmental concerns into doctrine, the Army's small-unit leaders need guidance on how to face their ever-growing list of environmental considerations. They need a basic resource to help them make sound decisions about how their training will affect the environment. To meet this need, the Engineer School recently released Training Circular (TC) 5-400, *Unit Leaders' Handbook for Environmental Stewardship.* It provides a general perspective of what the environment is and why it is a major factor in the decision-making process. The handbook also describes steps that leaders and soldiers can take to ensure that they comply with the environmental goals and policies of the Army and the numerous local, state, and federal laws and regulations. TC 5-400 is called the "Dash 10" of environmental considerations because it delineates the before, during, and after checks for conducting field training exercises. The Engineer School plans to revise the manual in FY96 and publish it as a 20-series manual.

Training

The philosophy used to design environmental training programs was "integration." Rather than developing stand-alone courses, the Engineer School integrated environmental considerations into all levels of existing training. School personnel also reviewed existing individual and collective tasks to determine if they needed modification.

Training Development Process

Most of the Army's training is centrally developed at TRADOC service schools. A unique opportunity exists if training developers throughout the Army are taught to incorporate environmental considerations into their training. To achieve this, the Engineer School integrated environmental information into the programs that train TRADOC's training developers, such as the Systems Approach to Training and the Middle/Senior Manager's Training Development Courses. If schools design training that delineates environmental considerations, they will resolve potential environmental problems that soldiers may face in the field.

Photo by Jim Anderson

Soldiers repair a vehicle using environmentally safe standards. Environmental awareness by troops is a relatively new concept in today's Army.

Individual and Collective Tasks

We must still work to ensure that environmental considerations are integrated into military occupational specialty (MOS) training. The integration is more urgent for some MOSs than others. For example, fuel handlers, heavy equipment operators, mechanics, and heavy weapons handlers require immediate attention. To meet this need, the Engineer School established a TRADOC-wide environmental work group with members from other service schools and proponents. Representatives of this group have the power to ensure that environmental training is incorporated into training products and doctrinal manuals.

The integration efforts of the Combined Arms Support Command (CASCOM), a member of the TRADOC Environmental Work Group, are a major success story. CASCOM is responsible for the service support branches, including Quartermaster, Ordnance, Transportation, and Missile/Munitions Schools. CASCOM recently released the Soldier Training Plan (STP) for MOS 77F, Fuel Handler. The possible environmental impact of a fuel handler is obvious, and CASCOM considered this when defining the tasks, conditions, and standards. It is an excellent example of how environmental considerations can be incorporated into operations without sacrificing mission accomplishment.

Like CASCOM, school proponents may establish an environmental task. For example, a 77F task is "Employ environmental stewardship measures." The standard is "Dispose of all hazardous waste in a manner which has no detrimental effects on the environment." The conditions are "Given any hazardous material or other material which might generate hazardous waste and two related manuals."

Additionally, the school proponent might develop a task that has environmental considerations as part of the standard. For example, for the task "Perform preventive maintenance checks and services (PMCS) on a 5-ton truck," the standard is "Perform operator's maintenance and operate the vehicle without injury to personnel, damage to equipment, or undue harm to the environment."

In the field, commanders can modify the conditions. For example, the task "Supervise PMCS" has the conditions "The leader is required to supervise operator/crews in conducting PMCS, given applicable technical manuals and forms, assigned equipment with crews and local spill contingency plans, and unit maintenance SOPs."

Resident and Nonresident Training. To support resident training, the Engineer School developed 13 training support packages (TSPs) for other service schools and proponents. These TSPs include training ranging from initial entry through the Sergeants Major Academy and from precommissioning to precommand courses.

These awareness-based TSPs contain baseline environmental knowledge, such as Army and unit environmental programs, applicable environmental laws and Army regulations, soldier and leader duties, and the environmental ethic. Each service school is responsible for placing the instruction into their programs of instruction. To maximize the effectiveness, the school should then integrate environmental considerations throughout the programs of instruction, including maintenance, logistics, training management, and leadership training.

To support the nonresident version of these TSPs, the Engineer School developed Army correspondence courses at the junior enlisted, company grade officers/junior NCO, and field grade officers/senior NCO levels.

Unit Sustainment Training. A video-based TSP, *The Unit and the Environment*, was developed to assist units in environmental sustainment training. It promotes environmental ethics, unit environmental operations, and the use of TC 5-400. The case-study video contains four segments that highlight compliance programs and how to conduct before, during, and after-action environmental checks during field training exercises. The training program, scheduled for fielding in August 1995, will be available through local Training Support Centers.

Installation Compliance Training. Installation compliance training is a specialized type of unit sustainment training. Since environmental laws, regulations, and resulting procedural guidance are site-specific, units must conduct installation compliance training. The Engineer School is finalizing development of the Installation Environmental Trainer's Course. This train-the-trainer course will be taught at the Army Logistics Management College at Fort Lee, Virginia. The concept is to train an installation- or brigade-level representative to serve as the commander's environmental advocate and further empower that individual to train subordinate battalion- or company-level environmental compliance officers. This is much like the current nuclear/biological/chemical officer concept in an engineer company except that unit environmental compliance officers probably will be NCOs.

The Engineer School is conducting course trials now and expects to have the course on-line in early FY96. Students may enroll through the Army Training Resource and Requirements System.

Posturing for the 21st Century

The Army now faces the largest restructuring of funds, facilities, equipment, personnel, and operations in its history. The base realignment and closure process will continue over the next decade. At the end of this restructuring, the Army will have the smallest number of divisions since before World War II. As these reductions occur, the base structure will decline, putting more pressure on installation training areas.

The amount of training land will not increase. For the Army to carry out its mission, we must decrease environmental damage and repair past harmful environmental impacts. Environmental considerations are important components to mission success because they affect safety, readiness, training budgets, training management, and local community relations.

Guidance from Army leaders has been direct. *The U.S. Army Environmental Strategy into the 21st Cenury* provides the strategy, the vision statement, and critical elements to guide development of supporting doctrine, training, and procedures. TRADOC has organized for success and has directed the Engineer School to spearhead the integration effort. The Army has committed the chain of command to ensure that he soldiers of the 21st century will be prepared to ace these challenges and succeed in protecting the nvironment for future generations.

Major Neeley is chief of the Leadership and Environmental Division at the Engineer School.

Captain Heitkamp is chief of the Engineer School's Environmental Branch.

This article is an excerpt from a paper written by Major Neeley and Captain Heitkamp which was presented to the 995 NATO Environmental Conference in Montreal, Canda. For additional information about environmental aining and doctrine, see the Engineer School's home page n the Internet (address is http://155.9.32.3) or call the nvironmental Branch at (314) 563-4122.

Every Little Bit Helps

By Mary Barber

Environmental stewardship and protection don't have to involve separate contractors and big dollars for sophisticated technology. Sometimes, the Army's environmental goals can be met by something as simple as moving rocks. Personnel at Fort Carson are doing just that on the Colorado installation. Boulder by boulder, they are establishing hardened sites at all major intersections in their training area to help fight erosion.

During maneuvers, troops occasionally meet to set up logistics points, hand out rations, collect trash, and fuel vehicles.Typically they rendezvous at intersections, parking their tanks and vehicles on the surrounding terrain. Over time, the terrain is reduced to bare dirt. During rainstorms, the intersections are inundated with mud and water, and troops look for areas that offer more traction, such as ground with vegetation. As a result, impacted areas spread farther and farther out, increasing the amount of erosion and sedimentation.

Hardened sites are a simple technology that provide soldiers a low-cost method of reducing erosion. Boulders the size of bowling balls are spread 1 to 2 feet thick over eroded areas. The rock settles into the ground and is topped with finer material so wheeled vehicles can be driven over it. These sites give troops a place to meet that will not become a sea of mud. As an added bonus, the vehicles will require less cleaning, saving both time and natural resources.

Initial feedback from troops indicate that the original quarter-acre hardened sites are too small, so they are being expanded to an acre. Even at this size, the sites will reduce terrain damage by several acres per site. Granted, it isn't a lot, but that's how we win this game, one boulder at a time.

Mary Barber is the Deputy Director of the Directorate of Environmental Compliance and Management at Fort Carson, Colorado.

We're All Terrain Experts

By Captain David L. Treleaven

"What do you mean, TDY to Bosnia! There are no Americans in Bosnia."

Wrong! There are a few. Most of them work on the staff of, or as liaison to, the Bosnia-Herzegovina Command (BHC) in Sarajevo. One of them is the G2 Geographic Officer, normally a U.S. Army topographic officer, who rotates through the position every 180 days.

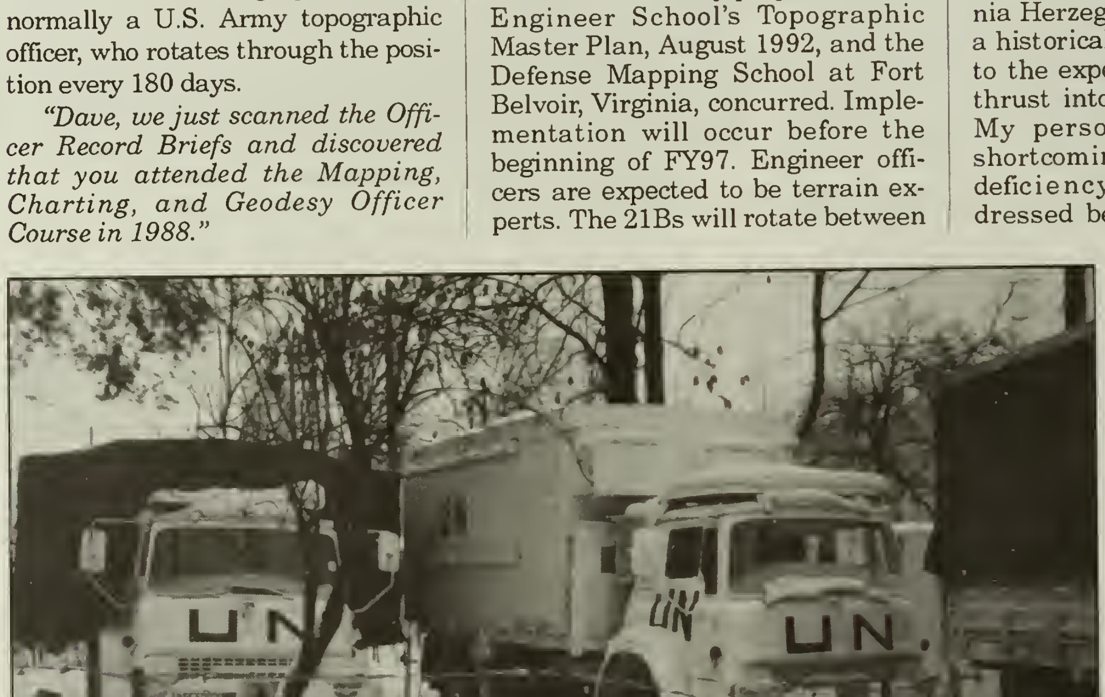
"Dave, we just scanned the Officer Record Briefs and discovered that you attended the Mapping, Charting, and Geodesy Officer Course in 1988."

"Sure, but you don't understand. I've never served in a topo unit."

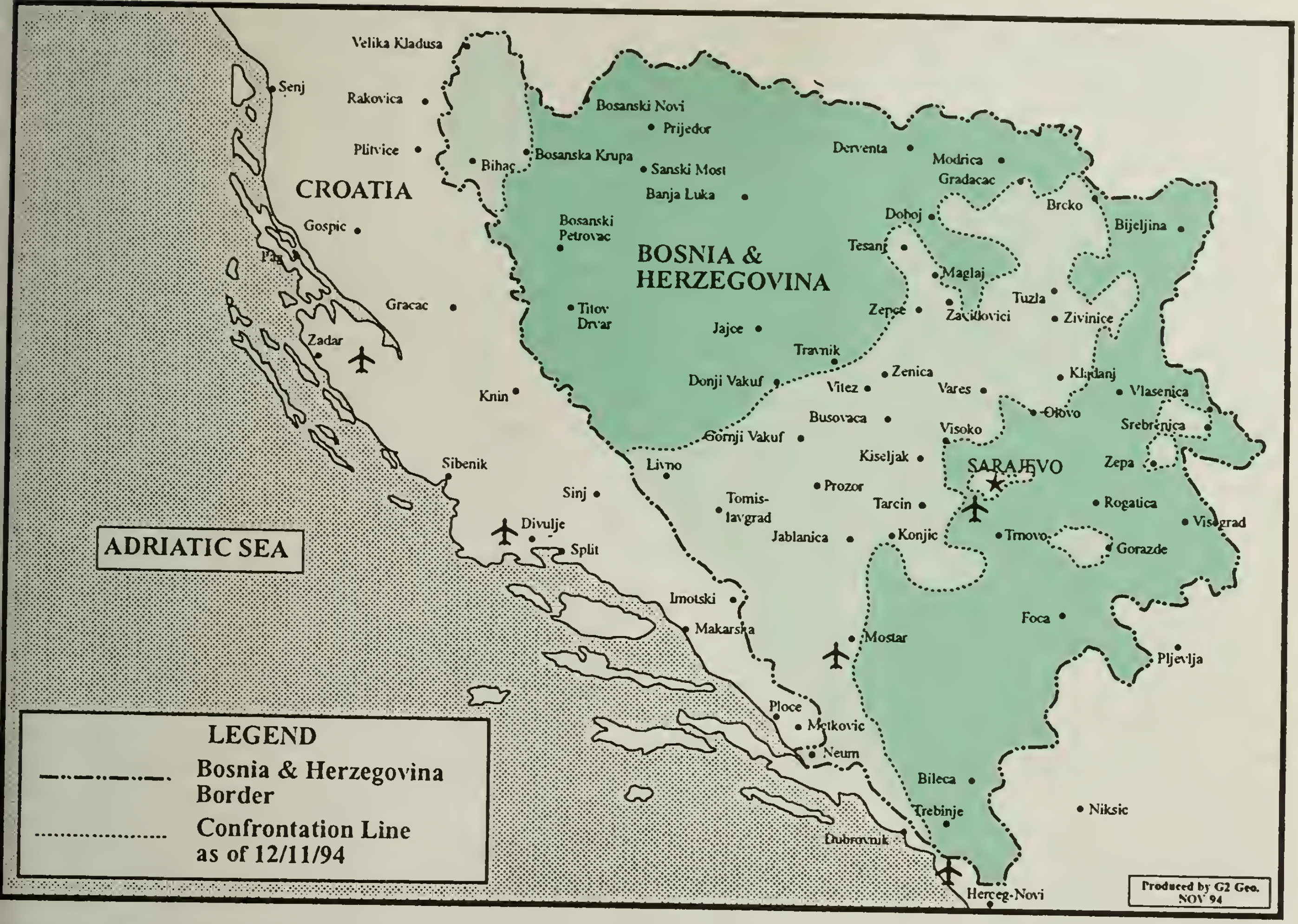
As I quickly learned, that isn't important anymore. In the near future, Military Occupational Specialty (MOS) 21C, Topographic Engineer, will consolidate with MOS 21B, Combat Engineer. The consolidation was initially proposed in the Engineer School's Topographic Master Plan, August 1992, and the Defense Mapping School at Fort Belvoir, Virginia, concurred. Implementation will occur before the beginning of FY97. Engineer officers are expected to be terrain experts. The 21Bs will rotate between combat, construction, and traditional topographic assignments. However, officers assigned to topographic units will still attend the Mapping, Charting, and Geodesy Officer Course at the Defense Mapping School.

This article does not attempt to deal with events occurring in Bosnia Herzegovina (BH) or to provide a historical perspective. It pertains to the experiences of a 21B officer thrust into a traditional 21C role. My personal frustrations and shortcomings point to a training deficiency that must be addressed before we can adequately label ourselves as both terrain experts and topographic officers. The topographic requirements of my BH mission, and operation-other-than-war scenarios in general highlight some of the problems. The good news is that the Engineer School is doing something about it.

What are the problems? Let me give you a few. Do you know the difference between European Datum 1950 (ED50) and World Geodetic Survey 1984 (WGS84)? Can you convert coordinates between these datums? Do you know the basics of the photolithographic process? Do you know the meaning of gazetteer? Are you familiar with REPMAT? Have yo



Two 4-ton Bedford trucks used by the Bosnia-Herzegovina Command. The truck on the right housed the ROTAPRINT single-color printing press. The truck on the left served as a map depot. Its expandable bed was used as a catwalk to access storage racks on the vehicle.



This map of Bosnia and Herzegovina is a typical briefing product produced by G2 GEO.

eard of the Digitized Terrain Elevation Database and its accuracy? Are you well acquainted with Terrabase? I didn't know these things, but this mission demanded that I earn them—and fast. Be prepared; his could happen to you!

United Nations Protection Force

M*ission.* The BHC mission was to act as a United Nations protection force (UNPROFOR) for the humanitarian relief ffort in Bosnia. Implied responsibilities of the mandate have aused the mission to increase. ecause the current situation in osnia is extremely complex, the HC has achieved limited success s a peacekeeping force and as a egotiating body between the Bosnian Serbs and the Muslim/-Croat federation.

Force Structure. The UNPROFOR—with headquarters in Zagreb, Croatia—has two major commands: Croatia and Bosnia-Herzegovina. The BHC has three major subordinate components: Sector Southwest, Sector Northeast, and Sector Sarajevo. Smaller, separate elements include forces in the Muslim enclaves of Bihac, Zepa, Srebrenica, and Gorazde. (Srebrenica and Zepa were overrun by the Bosnian Serb Army (BSA) in July. However, the situation is not clear and the future of these enclaves is uncertain.)

The Scene. The journey to Sarajevo begins in Zagreb with the Joint Task Force Provide Promise (Forward). Support for the Americans in Bosnia is only a small secondary mission for the task force. Its main focus is a US hospital at Pleso Air Base and airlift operations. After inprocessing at Pleso, one must board a UN aircraft into Sarajevo. This is usually an IL76 jet that the UN charters from the Ukraine. The approach and landing into Sarajevo requires wearing a flak vest and a kevlar helmet because Serb small-arms fire frequently punctures aircraft fuselages.

Getting in and out of Sarajevo is not simple, particularly for U.S. personnel. The air bridge closes frequently at the will of the BSA. It was closed continuously for almost a month during my 120-day tour. Getting out by land is technically impossible. There is a general order from the joint task force not to cross Serbian checkpoints. Sarajevo is completely surrounded by Serbian-controlled territory.

G2 GEO Team

At the BHC headquarters, I joined an all-British G2

GEO team. The British use "GEO" (geographic) as we use "TOPO" (topographic), so the terms are interchangeable. In addition to myself, the five-man GEO team consisted of a staff sergeant (the noncommissioned officer in charge), two lance corporals (the terrain analyst and the printer), and a sapper (the map storeman). I soon discovered that our common language barrier was minor compared to the disparity in our professional language. The "topo jargon" they spoke was not an attempt to baffle or impress me; it was simply an efficient way of communicating within their technical specialty. I made a mental note to master this dialect.

The team's work space consisted of two container-type offices with a third container for supplies. Our primary equipment was a 486 computer with a bubble jet color printer, a dyeline machine, a light table, and two Bedford 4-ton trucks. One truck served as a map depot and had an expandable deck and shelving. The other one housed a ROTAPRINT, a single-color mechanical printer, and associated peripheral equipment. The British Army used the ROTAPRINT to produce tactical information prints (TACIPRINTs).

G2 GEO Mission

The G2 GEO mission is to provide geographic support to the BHC staff—terrain analysis and advice, TACIPRINTs, and briefing products. In addition, the GEO section distributes maps to the BHC staff and bulk issues to the subordinate sector commands.

Maps. We stored and distributed eight different map series and dozens of special products, but only two series were Defense Mapping Agency (DMA) products. Most units preferred the map produced by the former Yugoslavia, which commercial contractors in the United Kingdom overprinted with a WGS84/universal transverse mercator (UTM) grid, the theater standard. What made these maps (the UNPROFOR 1002 series) desirable was the updated information and a color scheme that highlighted lines of communication, supply routes, confrontation lines and other boundaries in urban areas, and other man-made features. By comparison, the unpopular US M709 series (1:50,000) maps were outdated and emphasized contours and relief information in general. They were overprinted with WGS84 tick marks along the margin instead of a full grid. When map sheets were joined, the WGS84 grid was lost.

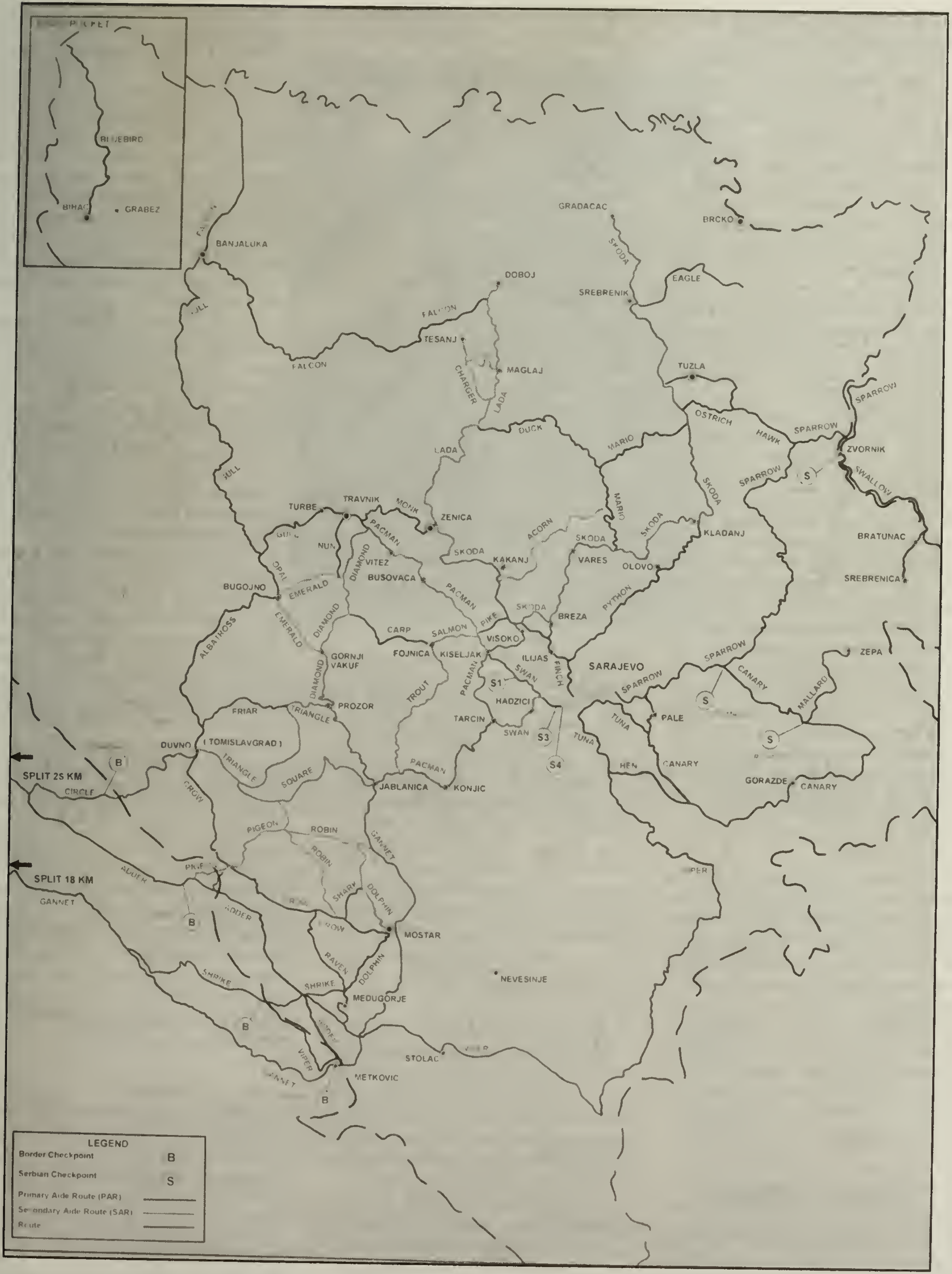
Get used to the idea that there are more than DMA maps out there. How do you develop a strategy to capitalize on other products and alter them to your operational requirements? This had never been part of my training, but the real eye-opener was the remarkable ability of my British team to assist multinational staff officers who came in with only a vague idea of what they needed. Within minutes these officers would walk out smiling, carrying the precise type of terrain documents needed for their mission. While our terrain teams provide the same type of advice as the Britons, we need to decentralize this capability and train task force engineers to provide this information to their maneuver commanders.

Geographic Advice/Expertise. One of our most essential functions was to convert grid coordinates between datums. Bosnian Army (BIH) and BSA proposals for safe areas, heavy weapons exclusion zones, boundaries, and other items in the negotiation process were derived from Yugoslavian maps with a Gauss-Kruger grid (Hermanns-Kogel datum). The first time the G2 handed me a list of grid coordinates to convert, I had no idea how to proceed. Eventually, I made the conversion to WGS84/UTM with a program developed by the British Army's 42d Survey Engineer Group. At the time, this 21B had no knowledge of conversion software (MADTRAN) developed by the Defense Mapping School for that purpose. Two hours of computer-assisted instruction in the Engineer School lab could have eliminated this problem.

Terrain Analysis. I felt confident about my knowledge in this area. After all, I am an expert on analysis of observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA) and engineer battlefield assessments. However, the BHC mission was peacekeeping, not peacemaking, so traditional OCOKA analysis was seldom relevant. How do you analyze terrain when you are not trying to determine its effect on large Krasnovian formations? How does it affect the operations of primarily regional militias? The Mount Igman demilitarized zone, which we overprinted on standard 1:100,000 maps, is an excellent example of good terrain analysis in Bosnia. Establishing the zone on the high ground southeast of the Sarajevo airport was a win-win situation for the BIH, the BSA, and the UN. Delineating the demilitarized zone prevented the BSA from having clear fields of fire on the UN's only aerial port of debarkation. It also prevented the BIH from putting fires on Serb main supply routes.

Does that sound like a brilliant UN coup? The story I heard was that the warring parties actually proposed the zone. Unfortunately, the UN has never been able to fully enforce it. On the positive side, G2 GEO used Terrabase software to develop a rough outline for proposed warring faction boundaries using terrain features to mask factions from each other. It was also used to designate initial positions for UN observation posts using line-of-site plots. Elevation tints were produced for G2 contingency planning for possible air routes into the Bihac pocket for NATO strikes. I drew from my limited Terrabase experience as an Engineer Officers Advanced Course small-group instructor but relied on the expertise of the GEO team to produce these products. However, we were all baffled when we could not print to scale. It took weeks to find out that Terrabase print drive functions were written for dot matrix printers, not our laser or bubble jet printers.

Briefing Products. A common denominator for operations other than war is the need to conduct extensive briefings, mostly for public information. Almost half of our work involved developing color products for press briefings. We took several scanned map backgrounds and used Aldus Freehand



A TACIPRINT showing convoy and supply routes in Bosnia-Herzegovina software to overlay data on them. These techniques were all new to me. An idea began to form in my mind that terrain experts must be somewhat technocratic, which implies hands-on training. They must at least become familiar with system capabilities and be comfortable with new systems being fielded. Our G2 GEO section's somewhat shabby system pales in comparison to systems fielded today. I have subsequently learned that systems like the Multispectral Image Processor and the Quick Response Multicolor Printer have powerful capabilities to produce tactical decision aids (see "Terrain Visualization," *Engineer*, April 95, pages 32-35).

TACIPRINTS. Mechanically printing TACIPRINTS took most of our time. We produced them for, warring factions, UN dispositions, withdrawal routes, BH transmission lines, and minimum-risk lines of communication. Most TACIPRINTS are five-color jobs with each color layer successively overprinted on the grey base map. The administrative or technical information overprinted on each color layer was prepared the old-fashioned way—by a draftsman bending over a light table. About 1,500 sheets were typically printed and distributed to some 60 military and political headquarters worldwide. Because of the manual drafting involved, this system is not very responsive. The minimum justifiable run is 500 copies.

The entire printing process was new to me, so I learned it from scratch. Do engineer officers need to learn the mechanical printing process? I don't think so. However, they must understand and exploit the capabilities of systems such as the Digital Topographic Support System and the Multispectral Image Processor to overlay layers of information on background maps and to print the maps with Quick Response Multicolor Printers.

Lessons Learned

Local Maps. Their quality may be better than the DMA products. Even if it's just a road map that's well-suited for convoy operations, responsive topographic support must include the ability to rapidly regrid and reproduce these maps. Local printing can be used if it is prompt and compatible with operations security.

Responsiveness. Peacekeeping inevitably involves basic negotiations over real estate. Any successful negotiation must end with the parties signing some sort of geographic product, whether its the outline for a demilitarized zone, a boundary, an exclusion zone, or a safe route. Topographic support must include the ability to generate these products rapidly in small quantities, since speed and dissemination help legitimize the peace process. The G2 GEO team's automation capability was just not sufficient.

Global Positioning System. US engineers in operations-other-than-war environments must form training teams to educate participating forces from third world countries on the Global Positioning System. This became an operational requirement for the G2 GEO team.

Terrain Visualization. Terrain visualization using tools such as Terrabase can be a great aid. Training on digitized terrain databases and applications must be included in formal 21B training. Although Terrabase is an aging system, it can point the way and prepare 21B minds for more powerful applications on the horizon. In the future, terrain visualization will decentralize from the terrain teams, and engineer companies will bring new tools to the Task Force Tactical Operations Center.

Terrain Experts

The MOS 21C/21B consolidation is timely. Training deficiencies can be addressed as part of the Engineer School Commandant's approval to restructure the programs of instruction (POI) for the Engineer Officers Basic and Advanced Courses.

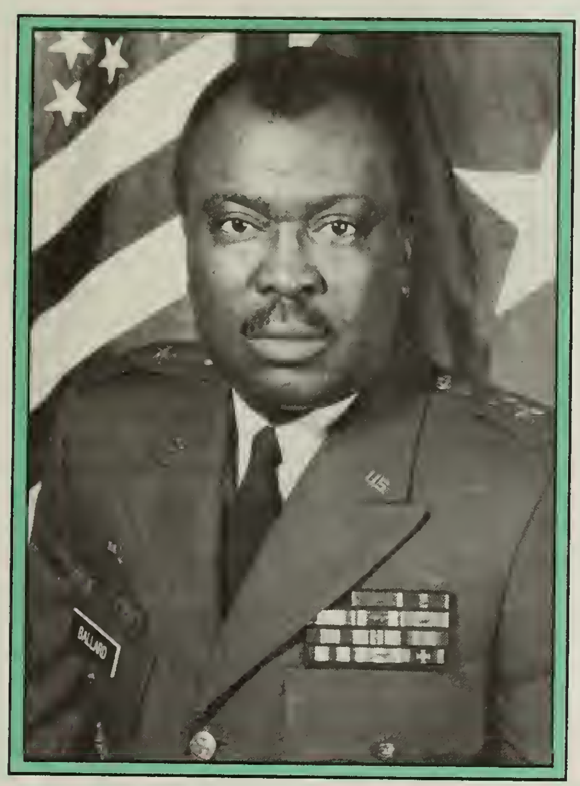
The Department of Training, Leadership and Engineering (DTLE) recently sponsored a think tank to define the required capabilities of future graduates. The result was a terrain task list. Lesson plans for this task list will expand the Basic Course POI from 1 to 16 hours of terrain analysis. The Advanced Course POI will increase from 6 to 32 hours of terrain analysis and visualization. The Defense Mapping School will closely assist DTLE in developing and resourcing lesson plans. The surge in instruction hours alone does not reflect the increased emphasis on terrain visualization because terrain visualization products also will be integrated into tactics instruction and practical exercises.

With funds received to upgrade computer lab equipment, the Engineer School will purchase 16 pentium-driven computers with large screen monitors (at least 17-inch), 32MB RAM, and ROM readers. The lab will also acquire full-size color printing capability, making it possible to run systems such as Terrabase and new systems like the Terrain Evaluation Model.

New POI provide more thorough training on OCOKA analysis and incorporate more powerful tools. But the POI shouldn't stop at enhancing conventional terrain expertise that engineers bring to the maneuver tactical operations center. Engineer officers must become comfortable in more traditional topographic capabilities. Graduates must train on digital terrain databases and products. They must know how and where to get multispectral imagery or image maps and how to use and interpret them.

Consolidation of the 21Cs/21Bs and my painfully learned lessons in Bosnia point to a shortfall in engineer training. This deficiency must be addressed before we can declare ourselves topographic officers and terrain experts. The Engineer School has taken the first firm steps toward achieving that goal.

Captain Treleaven is a small group instructor for the Engineer Officers Advanced Course. He served as platoon leader and company XO in the 41st Engineer Battalion, 10th Mountain Division. He commanded D/9th Engineer Battalion during Desert Storm and served in Somalia. Captain Treleaven holds a bachelor's degree in electrical engineering from Carnegie-Mellon University, Pittsburg, Pennsylvania.



Interview With
Major General Joe N. Ballard

Q *Since you have been at the Engineer School as both the assistant commandant and commanding general, you have witnessed the redesign of the engineer force with the engineer restructure initiative (ERI). How or what do you see as the next major evolution of the branch?*

A That's a very profound question. The next evolution of our branch may take place without much input from engineers and we must watch that. The Army currently is participating in an exercise called *Mobile Strike Force-Prairie Warrior.* That exercise may lead to a redesign of the division and, as that happens, we must determine the engineer force design changes needed within the division. Engineers have diverse roles within light divisions, heavy divisions, at echelons above division, and at echelons above corps.

I see engineers becoming much more focused on survivability and mobility missions than we have been in the past. We must decide if we need to maintain a heavy divisional engineer brigade structure and what the command and control piece should be.

I think we should focus on increasing our role in survivability in terms of command and control, including integrating the MP and the chemical contributions. Now that is revolutionary! As the Army downsizes, engineers must think "outside of the box" if we want to remain viable players in Force XXI. ERI was a major step forward but we must go further.

Q *How do you see the Engineer Branch changing in response to Force XXI?*

A Force XXI is a concept not a blueprint! No one can say what the Force XXI Army will look like because our testing, experimenting, and modeling are not finished. As General Sullivan said, it is a journey not a destination. In that respect, the engineer piece probably can be whatever we want it to

Interview by Catherine Eubanks

be, if we capture the intent of General Sullivan's message. How do we fight with a smaller, more sophisticated Army, in terms of engineer roles and missions? We are evolving into an information-based Army, harnessing computers to process information. When we think of engineers, we often think of dozers, graders and equipment that, at first glance, is not very sophisticated. But we can put many sophisticated systems in place with those machines. We must think about how engineers will support a fast-moving, power-projection Army.

The Engineer Branch will change—some changes are taking place already. Topographic engineering, one of the main tenants of our regiment, has changed significantly. A few years ago we needed several large expandable vans, a Heidelberg press, and so on, to produce map sheets in theater. Today, all the equipment needed to produce map sheets can fit easily on the back of a 2 1/2-ton truck; our goal is to fit it on the back of a HMMWV. Those improvements mean that topographic companies are no longer necessary. We must change the way we do business and not be afraid of that change.

Q *When you say that we don't need topographic companies, do you mean that only parts of a topo company will be needed in theater instead of an entire company?*

A No, I mean that large topo companies are no longer a viable concept. Modern computers have made that organization obsolete. Today we can put the inventory of maps on a CD ROM. We don't need to send pallets and shiploads of maps to a theater the way we did during World War II, in Korea, and in Panama. We can give a unit a CD ROM that has topo information for the specific area of operation on it. Soldiers will be able to print paper products or to send electronic maps to a receiver anywhere on the battlefield, even inside a tank. And, we can update data on the CD ROM from the U.S.

This is powerful technology, and we have much of that capability today. Now we must decide how best to provide topographic support. We have already proposed an initiative to eliminate the topographic engineering area of concentration for officers. Instead, we will train all engineer officers as topographers at the Engineer School.

Q *As the Army continues to modernize toward Force XXI, how do you see engineers supporting the maneuver force? What are the major priorities for new equipment?*

A If we are talking about the heavy division of the future fighting a conflict like Operation Desert Storm or that we envisioned taking place on the West German plain, then we definitely need to modernize. The ACE was the first modern piece of combat engineering equipment that we had produced in more than 40 years. That is a shameful situation for our regiment. I'm happy to say that the two previous school commandants (Generals Dan Schroeder and Dan Christman) and I have put an aquisition program in place to change that. Acquisition of the Grizzly (Breacher) and the Wolverine (Heavy Assault Bridge) started with Dan Schroeder. Building on his vision, we decided to mount them on M1 tank chassis as an interim replacement for the Armored Systems Modernization-Counterobstacle Vehicle (ASM-COV).

The program stayed alive under General Christman and we now have the final products. I have actually driven the Grizzly! Some 380 of them will be produced in the next five years, and they will completely modernize our heavy engineer force. We are working on the Wolverine and the new heavy assault bridge (HAB). In addition, the intelligent minefield will change land-mine warfare as we know it today. With it, engineers place themselves firmly on the 21st century battlefield.

The centerpiece of the intelligent minefield is the wide-area munition (WAM). It gives the Army the capability to shape the terrain, which is an important part of warfighting and a key tool in the intelligence preparation of the battlefield (IPB) process. The WAM is a sensor as well as a warfighter and has tremendous capabilities.

From a budgeting viewpoint, our modernization plan is aggressive and quite robust—we have a solid plan for equipment modernization over the next five years. With it we will acquire several new pieces of equipment. These items are in the budget and they are funded. It is not a wish list. However, we must remain vigilant so that those funds are not nibbled away during budget cuts.

Q *As you imply, new military equipment items are difficult to fund and, when funded, difficult to maintain through production and fielding. What material systems do you see as absolutely essential to prepare engineers for Force XXI?*

A There is a whole kit bag of things. The Grizzly, the Wolverine, and the WAM, which I just mentioned, are major items. Another is CIRCE, which is a key piece for an intelligent minefield. Important topographic initiatives include the combat terrain information system, multispectral imagery processing, and the series of topo systems that allows us to provide digitized terrain data. That clump is absolutely essential. It's funded now, and we can't afford to lose it. We must stick to a modernization plan that includes procurement of construction, diving, and firefighting equipment as well as the combat piece; eliminates obsolete systems; and maintains combat readiness.

The Engineer School has a well-laid-out acquisition plan, and we are watching it carefully through the TRADOC Systems Manager and the Directorate of Combat Developments. The systems I mentioned are critical; they are funded and must be produced. Our acquisition plan must stay intact.

Q *Will you briefly explain the multirole bridge company (MRBC) concept? Specifically, address how the MRBC concept will affect the engineer force and what it will do for maneuverability and engineer support to the combined arms team.*

A The multirole bridge company grew out of the Army's downsizing effort and was created because of funding constraints. If we had a requirement for fixed bridging in the past, we sent a fixed bridge company to construct it. Float bridging was constructed by a float bridge company. After a 33-percent cut in force structure, we no longer had the luxury of independent companies for specific missions. MRB companies provide both bridge types from the same organization. The Palletized Load System, the improved common bridge transporter, makes this possible. Now a bridge company can quickly download one type of bridge and upload the other type. The MOS 12C soldiers have no problem with that because they are trained on both types. The dual capability provides a synergistic impact: we can emplace one bridge type immediately and still have the other type readily available. While based on economic constraints, the concept is so simple and so good that I don't know why we didn't think of it before.

The impacts of the MRBC on mobility and engineer support to the combined arms team are obvious. A key benefit is that our bridging capability will not be degraded when we move many old bridges into the Reserve Components (RC). If we deploy, there is enough bridging in the Active Component (AC) to meet initial needs—we don't need to wait for the RC units to mobilize.

"The WAM gives the Army the capability to shape the terrain."

Q *How do you see the role of noncommissioned officers (NCOs) changing to meet Force XXI requirements? For example, will NCOs perform some tasks and assume some responsibilities formerly accomplished by officers?*

A I don't see NCOs assuming engineer officer responsibilities but they will assume a more robust role in Force XXI. We will still have platoon leaders, platoon sergeants, and squad leaders. Their responsibilities won't change; squad leaders, for example, will still lead squads. But we must make sure that NCOs become full players and participants in the concept we call ENFORCE XXI.

Earlier we spoke about new technology on the battlefield. The person at the point of application is the small unit leader—a staff sergeant. That NCO must have the wherewithall to deal with all of that data and equipment.

How well prepared NCOs are is a different question. The challenges for a 21st century NCO are staggering. Through technology, the small unit's impact on the mission will become readily apparent to everyone up to the corps commander. We must make sure that unit leaders are prepared to deal with the many different situations created by new technology.

The real question is how we will train engineer officers and NCOs. The Army currently has separate education systems, but in the future I think that engineer soldiers must share some training. We must combine common subjects and make sure that officers and NCOs are trained to the same standard.

Q *How will the changing roles of women in the Army affect the engineer force?*

A Although we are a combat arms branch, we can't shy away from this question. As the engineer force changes, we can't forget the large number of females in our branch and in our Army. They will have an ever-increasing role. We have opened MOS 12C, the bridge crew member, to females—the first female 12C soldiers are receiving One Station Unit Training (OSUT) on Fort Leonard Wood now. Will females have a negative impact on the engineer force? I don't think so. I think there are good opportunities for females in the Engineer Regiment.

Q *Can you explain where Army engineers are going in the joint arena?*

A We have had extensive discussions about the roles and missions of all services during the past few years. I don't know if much will emerge from those discussions except for a greater understanding of each service's roles. The positive thing I see emerging is that we will fight and operate more often in a joint environment. All of the dialogue has given us greater appreciation and understanding of the individual services' capabilities, and cooperation will increase.

Q *You have championed the independence of engineer command and control elements, especially in echelons above corps. How do you envision joint engineer command and control, particularly the concept for a Joint Force Engineer Command?*

A Engineers need to maintain a certain amount of independence, especially in echelons above corps. Let's talk about theater construction management because that is inherently a joint engineer operation. The regulation that deals with theater construction management and who has specific responsibility is clear. It states that the Army is responsible for all construction in support of the land-force commander. While the Navy also has a role, the Army has ultimate responsibility for construction in a theater during a major regional contingency. Our Engineer Commands (ENCOMs) and Theater Army engineer brigades are well suited for that mission.

Army engineers probably are better suited for some tasks than the other services because of the way we are organized, the tasks we train on, and the skills we bring to the fight. I don't know about a joint force engineer command concept. I have an opinion but it remains to be seen.

Q *With the threat becoming regional in focus and global in scope, what role do you see for Army engineers in operations other than war (OOTW)? Does that threat include possible domestic scenarios?*

A Army engineers have been involved in military OOTW missions, including nation building and nation assistance, for many years. Examples include Operation Provide Comfort in Iraq and Operation Uphold Democracy in Haiti. On the domestic scene, we provided support after Hurricane Andrew in Florida, for the 1993 Midwest floods, and for fighting fires out West. Engineers have a continuing role—if anything, a greater role—in these types of missions. Our nation is putting more demands on Army engineers to get involved in these scenarios. I think that's good.

Q *Joint engineer training is becoming a reality at Fort Leonard Wood, Sheppard Air Force Base, Camp Lejeune, and elsewhere. What major benefits do you see to this initiative? What quality-control measures are in place to ensure that all services' training standards are met?*

A The biggest benefit accrues to the Department of Defense and that's the savings in tax-payer dollars. It's a lot cheaper to train all drivers of equipment at one location instead of four. We train individuals from all services how to drive dump trucks, for example, at Fort Leonard Wood. Joint training is driven strictly by economics.

We have worked through the Interservice Training Review Organization (ITRO) to ensure complete agreement on standards for training. All of the services have agreed to one set of standards. We have also agreed on training standards for the instructors to ensure they are training the same way and using the same programs of instruction (POI). The only difference between one instructor and another is the color of his uniform. We have also made provisions for break-out sessions, where we will train things that are service unique. In effect, the standards for quality control are in place.

Q *Are there any hurdles we need to overcome to meet deadlines and fully implement the ITRO program?*

A No, we have worked hard on this program over the last few years, and we have crossed all of the major hurdles. We have agreed on lesson plans and instructor training, and the facilities are in place. We are very comfortable with this.

Understand that joint training is not entirely new. The Air Force has trained our firefighters for years, and the Navy has trained our well drillers. We have trained the other services in topography. Now the ITRO initiative allows us to focus on other areas. ITRO is not a new concept, it's an expanded concept.

"The challenges for a 21st century NCO are staggering. Through technology, the small unit's impact on the mission will become readily apparent to everyone up to the corps commander."

Q *Let's talk about the Reserve Components (RC). About 75 percent of the engineers are in the reserves. How do you see RC engineers interfacing with their Active Component (AC) counterparts in near- and mid-term operations?*

A Our branch is really more of an RC branch than an AC branch, and I don't see a problem with that. Many of the things that engineers do can be done as well with reserve as with active forces. The mixing of RC and AC engineers is not new. We have been doing nation assistance projects in South America for several years with a blend of Guard, Reserve and Active units. I've had very positive feedback about the preparedness and capabilities of RC engineers now deployed to Panama and to the joint peacekeeping operation in the Sinai.

The only differences between AC and RC units are the coordination and synchronization between the RC engineer commander and the AC task force commander that he supports. We can rehearse and practice the interface piece, so I don't see that as a big problem. All engineer officers, NCOs, and the enlisted corps are trained at Fort Leonard Wood with the same standards. The Engineer School writes the same doctrinal manuals, mission training plans and everything else for the entire regiment. Regardless of the component, I don't see a problem.

Q *Are there any doctrinal issues you would like to address?*

A Doctrinal issues go back to the question about the roles of the engineer force in Force XXI—all of that is driven by doctrine. FM 100-5 and our new FM 5-100 both talk about change. We must examine the roles described for engineers in FM 90-13-1, our breaching manual, to make sure that we change as we move to meet the demands of the 21st century. Generally, I think we should wait and see what the new division and corps redesign efforts are and then update our doctrine accordingly. Right now we are writing doctrine that supports current roles and missions, but we must fine-tune and tweak our doctrine as the engineer organization evolves.

Q *Let's discuss the Engineer School. In your opinion, how successful have engineers been in the battle lab process? What do you see in the future for a battle lab at Fort Leonard Wood?*

A I think that we have been very successful. There is no engineer battle lab at Fort Leonard Wood, but we made a conscious decision to place engineers in every TRADOC battle lab. Engineers initially are trained here and we give them guidance and instruction. When they are assigned to a battle lab, they work for the Commandant of the Engineer School. All of the battle lab commanders know and accept that. In addition, we established a small group of folks, called the Battle Lab Support Element, who ensure that engineer issues are embedded in every battle lab. It is critical to do that if we are to remain viable members of the combined arms team.

Will there be a battle lab here in the future? If we are successful in bringing the Military Police and the Chemical Schools to Fort Leonard Wood, then we probably will have a mobility/survivability battle lab here. The initial footprint for that idea was briefed to the TRADOC commander. I am optimistic that, if the BRAC initiative is approved, there will be a battle lab here.

Q *With TRADOC funding decreasing, what Engineer School functions do you feel are most important to maintain? Where might we expect to see economies?*

A Fort Leonard Wood has three core processes: teaching, writing and doctrinal development; training is included in the teaching portion. Functions related to those core processes will be the last items cut. We probably will seek economies in anything that does not relate directly to the core processes.

Q *There is an Engineer School initiative to consolidate training for MOSs 12B and 12F enlisted soldiers. What do you see as the advantages of this consolidation?*

A The concept for the 12B/12F consolidation has been given wide-range support, and the TRADOC commander has given us the go-ahead. As the Engineer Regiment downsizes, we must carefully analyze every engineer MOS. The engineer career management field (CMF) is one of the largest and most diverse in the Army, and some MOSs, such as firefighters and divers, have less than 100 folks in them. Promotion opportunities and career progression for individuals in those MOSs are limited. For example, soldiers in MOS 12F are quickly promoted to the grade of sergeant, but promotion stagnation occurs in the higher grades. Combining the 12F and 12C MOSs enables us to provide good career progression and to protect the force structure of the Engineer Branch.

There was another purpose for this consolidation. The AVLB and the CEV are obsolete and we have difficulty maintaining them. Therefore, we must have the capability to quickly transition to the HAB and the Grizzly. This consolidation will ensure that trained folks are ready to operate and maintain the new equipment. Now this is key: I'm not talking about force structure protection here. I'm talking about having a force that is ready to operate new equipment when it comes on board. Preparedness. We must have combat engineers trained to operate combat engineering equipment—that's the bottom line.

Q *How do you see the Engineer Officer Basic and Advanced Courses (EOBC/EOAC) changing to better prepare officers for the 21st century?*

A We touched on this earlier. As we head for the 21st century, the challenges for engineer soldiers are tremendous. They must be versatile, technologically aware, trained to handle massive amounts of data, and skilled in operating in a highly lethal environment. We don't do a very good job of training officers or NCOs to deal with the many advanced systems on the battlefield.

This is not an indictment against engineers. My counterparts at the Infantry, Armor, and Field Artillery Schools are evaluating how to change leader development to meet the demands of the regular Army in Force XXI. Engineer School personnel are analyzing our POI to determine how to deal with that. We are focusing on the tactics and the topo portions—we want to roll those pieces into something that gives soldiers the tools they need to be successful company commanders or platoon leaders. We are designing a new POI; our plan is to test the model this winter and put it in place by the beginning of 1996.

Q *What plans are there to fully modernize the Engineer School to meet 21st century needs?*

A As we modernize the Engineer School we must also modernize all of Fort Leonard Wood. We made some hard decisions this year to install fiber-optic links, various LANs, and telephone switches to move away from old technology (hard wires and twisted pairs) and to open Fort Leonard Wood to the Internet via the World Wide Web. We can now browse and interface with the whole world. Having made the capital investment, that technology will be a reality here in few years. Then we can move information within Fort Leonard Wood and the Engineer School as well as within TRADOC, the Army, and the world.

In addition, we want to do interactive simulations. We have committed to participate in the Defense Simulation Internet (DSI) and the Distributed Interactive Simulation (DIS). DSI, DIS, and our efforts to design classrooms for the 21st century (Classroom XXI) will allow us to do distance learning in the classroom using multimedia technologies. Instead of bringing RC students and officers to Fort Leonard Wood, we will have classes in session here and, at the same time, teach appropriate RC students in various locations. We are at the doorstep of doing that now. That is a significant achievement!

Q *I understand that the Engineer School is working to clarify the role of engineers with regard to unexploded ordnance (UXO). Can you explain the engineers' role in this arena?*

A The UXO issue keeps resurfacing. According to doctrine, responsibility for UXO belongs to the Ordnance Corps and their Explosive Ordnance Disposal (EOD) teams. On today's battlefield, UXO creates a real and deadly challenge to mobility and survivability. Engineers must deal with UXO ranging from large ordnance to cluster bomb units that are generated by friendly and threat capabilities. As our exposure to UXO increases, engineers are required to take on a larger portion of the UXO mission. Personally, I would like engineers to take over the entire UXO mission, which would mean a switch in doctrine. Don't know how the Ordnance School feels about that, but the two schools must carefully coordinate UXO responsibilities. Engineers can't walk away from the role of mobility and survivability of the force.

Q *In closing, do you have any words of advice for the Engineer Regiment?*

A I'm leaving Fort Leonard Wood but will remain active in the Engineer Regiment as Chief of Staff of TRADOC. These are exciting and challenging times to be an engineer soldier. It is critical that engineers remain engaged in the dialogue about Force XXI so that we continue to be major players. I am confident that Major General Gill will continue to lead us in that direction. It's been fun.

Thinking Through Force XXI

By Jeb Stewart

As the Army reshapes itself toward the image of the future digitized Force XXI, enthusiasm about "informational warfare" seemingly knows no bounds. Heidi and Alvin Toffler are the prophets and their book *War and Antiwar* provides much of the vision. I submit that there is much hype and more than just a bit of a "damn the torpedoes" attitude about everything associated with Force XXI. Not much circumspection is going on!

As the Army hurls toward Force XXI, we are assuming its form with little regard for some key considerations. We are spinning far out beyond the maneuver-based warfighting strategy we masterfully displayed during Desert Storm toward control warfare, where we limit our enemy's options before a battle takes place. Whatever he can do, we already have anticipated and countered before he can execute his plans. A wise enemy surrenders before we inflict inevitable defeat upon him.

Truly that's a great vision! I believe the Army needs to critically assess our expectations and temper our enthusiasm with some historical perspectives. We've misjudged visions before. As one example, in the aftermath of the Korean War, President Eisenhower articulated the vision called the "New Look." The New Look gave tactical nuclear weapons "near conventional" status. Spurred by the Wizards of Armageddon, President Eisenhower, who had impeccable military credentials, believed we could defend the nation more cheaply with strategic and tactical nuclear weapons than with expensive general-purpose forces. The effect on the Army was such weapons as Davy Crockett, the nuclear-tipped recoilless rifle, and such organizations as the Pentomic divisions. Even before the collapse of the Soviet Union, it appeared that the wizards were wrong (or as some even now might suggest, only premature). My point is that we must periodically reassess visions for relevancy.

Force XXI assumes a technologically capable adversary. Information dominance presumes the enemy will collect and distribute as much, if not more, information than we do. There is always great danger in underestimating an enemy! But sometimes there is danger in creating a mirror image of our capabilities. The enemy may be radically different and we may not have time to sort out the differences. Or we may waste resources on a paper tiger. Remember how the Iraqi army was touted as "the fourth largest army in the world"? The distinction would have been important if we were trading lives as brave French and German soldiers did at Verdun. During Desert Storm, the distinction proved to be irrelevant. Perhaps we're guilty of some arrogance.

Technological superiority may be equally irrelevant. As the British author and poet Rudyard Kipling observed some 100 years ago, British infantry armed with the then-state-of-the-art "Martini" rifle could not dominate the primitive Sudanese warriors (the Fuzzy-Wuzzies). The British army based its defensive doctrine of the period on the hollow square, a nigh-impregnable formation that concentrated fires by volley. Kipling recognized the warrior factor—

"We sloshed you with Martinis, an' it wasn't 'ardly fair: But for all the odds agin' you, Fuzzy-Wuz, you broke the square."

It is hard to imagine that vital American interests could be endangered by the modern counterparts of these valiant but "backward" warriors, but consider the frustrations of recent operations other than war. The United States often commits its armed forces without a clear threat to our vital interests (e.g., Somalia, Haiti).

Perhaps the condition of Force XXI that worries me the most is the absolute reliance on computer software. All of us who work with computers have been the victims of poorly designed or poorly adapted software. I have sworn vile curses in utter frustration over software. I spent a good part of this May at Fort Leavenworth working for Prairie Warrior '95. I witnessed overstressed computer networks shutting down under the workload. One Warrior wit included in his "Top Ten Reasons Why We're in This Sorry Predicament," No. 5—"We were going to attack, but the computers crashed." Imagine the situation in combat when our Force XXI warriors get ominous and unintelligible software failure messages. The enemy may be less of a threat than our own software designers! Imagine also the links and interconnectivity that Murphy will find so challenging! We are arrogantly

(Continued on page 35)

Joint Task Force Headquarters Staff Engineer Operations

By Lieutenant Colonel Michael C. Langley

In today's fluid world environment, we can expect more U.S. military involvement in operations other than war, such as Somalia and Haiti, and lesser regional contingencies, such as Operation Just Cause in Panama. By doctrine and recent experiences, these operations will be joint and have a significant engineering effort. Engineer staffs must organize, prepare, and train to handle joint task force (JTF) staff engineer operations. Without such preparation, JTF engineer efforts will be delayed, inefficient and negatively impact mission success. While each lesser regional contingency and operation other than war is unique, most occur with little or no warning and require joint military operations in an environment with an underdeveloped or damaged infrastructure.

Three challenges we need to meet to fully integrate the Army into future joint engineer operations are described below. They are followed by Pacific Command and I Corps approaches to meeting those challenges.

Engineering Challenge

Recent operations show that the engineering challenge is normally disproportionately large compared to the total military effort. This challenge requires military engineers to engage in the following activities:

- Operating with other services.
- Operating with nongovernmental and volunteer organizations.
- Contracting for construction and services.
- Leasing real estate.
- Planning and executing joint operations.

The organizations, techniques, and tools available to accomplish these activities are not well known or are practiced infrequently. The engineer community has been proactive in some areas by developing joint civil/construction engineer training[1]. In other areas, such as construction standards, management, and component systems, little has been accomplished[2]. Without planning, organizing, and training in all areas, an ad hoc joint engineer staff will be ill-prepared to meet the joint engineer challenge.

Doctrinal Challenge

Recent joint operations show that joint engineer doctrine is scarce and outdated. The only doctrine available is Joint Publication 4-04, *Joint Doctrine for Civil Engineering Support*, which defines general engineering and facility terms and the responsibilities of the combatant commander or the JTF commander (CJTF). It does not provide joint engineer staff or organization structure. The publication states:

> *"Combatant commander engineering staffs (Active and Reserve Component members) are expected to be immediately prepared to respond to contingency and war operations. Execution is a service component commander's responsibility."*[3]

Another doctrinal publication, Joint Publication 5-00.2, *Joint Task Force Planning Guidance and Procedures*, is an excellent source for the general responsibilities, organization, and functions of a typical JTF. It provides joint staff planning procedures and checklists but has nothing specifically related to engineers.[4] Because of this, JTF engineer staffing usually falls under the realm of the JTF J4 section.

Staffing Challenge

Recent JTF planning and execution experiences also demonstrate the need for flexibility, with separate, expandable JTF engineer staffs.

I Corps JTF engineer staff augmentees from USCINCPAC, JTFCEM, USACE, NAVFAC, CREST and LOGCAP (Brown and Root Services Corporation) support Cobra Gold 94.

Because of mission requirements, these staffs ultimately became separate or independent JTF staff sections composed of 18 to 35 personnel. During operations, initial JTF engineer planning and execution were hampered by—

- Total adherence to staffing doctrine in Joint Publication 5-00.2.
- Inadequate manning of the JTF engineer staff.
- Lack of previous JTF engineer planning and training.

USCINCPAC Approach

The approach used by the Commander in Chief, U.S. Pacific Command (USCINCPAC) for contingency operations is two-tiered command and control. It includes USCINCPAC and a joint task force he designates—either the Third Marine Expeditionary Force, the U.S. Navy Seventh Fleet, or the U.S. Army I Corps.

To ensure that a JTF has expertise, USCINCPAC provides a tailored deployable JTF augmentation cell (DJTFAC) when a JTF is designated. USCINCPAC also forms a JTF contingency engineering management (JTFCEM) cell, consisting of reserve officers who are assigned to a designated JTF. These personnel assist with deliberate planning, exercise participation, and crisis response.

I Corps Approach

When USCINCPAC designates the U.S. Army I Corps as a JTF, the JTF engineer section's philosophy mirrors that of I Corps: flexible manning, based on mission requirements, and ease of transition. The I Corps JTF engineer section may be a separate staff or be located within the JTF J4, depending on the nature of the contingency and the magnitude of the engineer effort.

Philosophy. I Corps follows a formal joint task force standing operating procedure (SOP). Its JTF organization and staff can adapt to any type of operation: combat, peace enforcement, humanitarian assistance/disaster relief, support to domestic civil authorities, or noncombatant evacuation. The ability to transition from an Army corps headquarters to a JTF headquarters is critical to ensure minimum staff disruptions and smooth implementation of crisis action planning (CAP).

Organization. The JTF engineer is the principal advisor to the CJTF on all engineering matters. He supervises the staff and operation of combat and civil engineer units as well as activities in civil engineering; mapping, charting and geodesy; real estate; and environmental protection. He coordinates and chairs the Joint Facilities Utilization Board and the Joint Civil-Military Engineering Board.

The JTF engineer staff is formed around the existing I Corps staff engineer section. It contains administrative, operations (including topographic), and plans sections. The primary goal during the transition from an Army corps staff to a JTF engineer staff is to minimize changes to the organization and staff relationships. A major reorganization would hamper initial JTF planning and mission execution, especially during a crisis. To prepare for JTF operations, a staff must complete the following tasks:

- Develop a detailed JTF SOP covering organization, duties, augmentation requirements, crisis-action procedures, and joint boards.
- Identify organizations and individuals to augment the JTF engineer staff.
- Train within the section and in joint exercises, to include augmenting organizations and personnel.
- Maintain a library of joint publications.

Augmentation. The I Corps staff engineer section does not become the JTF engineer section simply by changing its name, reorganizing, and following the JTF SOP. Augmentation of both military and civilian personnel is required to provide joint military expertise and specialized civilian/private-sector expertise. Staff augmentation must occur as soon as the JTF is established to ensure well-balanced joint planning. A delay or a lack of augmentation may result in planning that does not use the full capabilities of all services and civilians.

- *JTFCEM Cell.* USCINCPAC provides a JTFCEM cell to I Corps. It is composed of two to five reserve engineer officers (Navy, Air Force, or Marine), who augment the I Corps JTF engineer staff. Depending on mission requirements, additional military personnel may be required. For additional Army personnel, I Corps mobilizes reserves from the 35th Engineer Brigade (ARNG-MO), who report to I Corps within 24 to 48 hours. Engineers from other services may be requested from USCINCPAC.

- *Topographic Support.* Most operations other than war occur in areas that have few current topographic products. The I Corps topographic detachment with state-of-the-art equipment (the geographic information system and multispectral imagery processor) deploys with the JTF engineer staff and provides essential topographic support. I Corps recently began requesting and receiving augmentation from the Army Space Support Team (ARSST), which provides additional capabilities, such as the high-resolution weather/satellite receiver and the mission-planning rehearsal system. Additionally, with ARSST support, split-base operations can become a reality with real-time overhead imagery for topographic use being forwarded to a deployed JTF from CONUS.

- *Contracting.* Recent JTF experiences have shown that solutions to JTF engineering and construction requirements, including real estate and logistics, are both military and civilian. Department of Defense contract construction agencies, the U.S. Army Corps of Engineers (USACE) and the Naval Facilities Engineering Command (NAVFAC), provide excellent contracting and real estate support. These agencies have personnel prepared to deploy on short notice to support JTF operations.

- *LOGCAP.* The U.S. Army's Logistics Civil Augmentation Program (LOGCAP) provides an additional civilian/private-sector capability through a USACE-administered contract. The current contractor is Brown and Root Services Corporation, which provides a wide range of engineering, construction, and logistical services. NAVFAC is developing a similar capability. The table shows typical augmentation requirements to the JTF engineer staff.

JTF Engineer Staff Augmentation Requirements

Quantity	*Description*	*Grade*
1	USACE or NAVFAC Contracting Officer	GS11/13
1	USACE LOGCAP Coordinator	GS11/13
1	USACE CREST or NAVFAC Real Estate Coordinator	GS11/12
1	LOGCAP Logistician	Contractor
1	LOGCAP Engineer	Contractor

Crisis Action Planning. Because a JTF normally does not have time for deliberate planning when it is first established, I Corps has developed the following CAP phases:

- Situation development.
- Crisis assessment.
- Course of action (COA) development.
- COA selection.
- Execution planning.
- Execution.

Additionally, I Corps has developed the checklist shown on page 23 to assist the JTF engineer section during crisis-action planning.

Joint Boards. Joint Publications 4-04 and 5-00.2 state that two engineer-related boards, the Joint Facilities Utilization Board and the Joint Civil-Military Engineering Board, may be established by either the combatant commander or the CJTF. Both publications give identical, brief descriptions of the boards with no details on membership or procedures. During CAP, both boards may convene to establish initial CJTF policies and to reconcile facility and real estate requests. To simplify establishing and conducting these boards during CAP, I Corps developed an SOP for each of them. The SOPs provide guidance to establish membership, procedures (from notification of meetings through voting), and verification and rebuttals of board actions.

The XVIII Airborne Corps established a Joint Environmental Management Board because of the increased emphasis on conducting military

Joint Task Force Engineer
Crisis-Action Planning Checklist

Phase I. Situation Development
1. Determine the mapping, charting, and geodesy requirements (coordinate stockage and delivery).
2. Provide the terrain-analysis team OPCON to J2.
3. Provide engineer support to the newly established JTF J5.
4. Provide an engineer to the crisis-action team.
5. Alert the JTFCEM and USACE (LOGCAP) for possible augmentation.
6. Determine the commander's critical information requirements (CCIR) and priority intelligence requirements (PIR).
7. Provide engineer input during the staff estimate process.

Phase II. Crisis Assessment
1. Request the JTFCEM and USACE (LOGCAP) augmentation.
2. Submit the component engineer liaison officer requirement to J3.
3. Continue the staff estimate process.
4. Notify the Defense Mapping Agency for possible support.
5. Coordinate with the theater topographic battalion for support.
6. Notify the U.S. Army Engineer School of support requirements.
7. Verify the legal authorities and types of construction funds.
8. Update the CCIR and PIR requirements.
9. Provide an engineer operations officer to JTF advanced echelon.

Phase III. Course-of-Action Development
1. Receive and integrate augmentees into the JTF engineer section.
2. Assist the J2 and J5 with preparation for mapping, charting, and geodesy.
3. Review plans that address specific contingencies.
4. Receive the warning order and perform a mission analysis.
5. Perform staff estimates and develop and analyze COAs.
6. Receive funding authorities and types of construction funds.
7. Receive and verify types and amounts of available host-nation support.
8. Verify the availability of reception and operations facilities.
9. Coordinate within the staff and component engineers: the optimum units, the status, and the possible unit tailoring for specified and implied missions.
10. Determine aerial port of debarkation or seaport of embarkation conditions, operational requirements, and required engineer support.
11. If conducting a disaster-relief operation, determine the impact of continued tremors, floods, and so forth, on engineer efforts.
12. Determine the engineer response for disease vectors of primary concern.
13. Convene the Joint Civil-Military Engineering Board.

Phase IV. Course-of-Action Selection
1. Continue receiving CCIR and PIR.
2. Continue monitoring the status of engineer units and support.
3. Draft the engineer annex, including the Civil Engineer Support Plan and environmental protection standards.
4. Convene the Joint Facilities Utilization Board.

Phase V. Execution Planning
1. Continue receiving CCIR and PIR.
2. Continue monitoring the status of engineer units and support.
3. Analyze the selected COA for engineer supportability.
4. Participate in JTF war-gaming of the selected COA.
5. Provide the engineer annex and input for the JTF operation order.
6. Begin engineer planning for redeployment and recovery.

Phase VI. Execution
1. Continue engineer planning for redeployment and recovery.
2. Perform JTF engineer functions according to the SOP and the operation order.

operations, especially operations other than war, in an environmentally responsible manner. I Corps and others should consider establishing this board also.

Training. I Corps is fortunate in having the personnel resources identified for JTF operations in addition to a wealth of training opportunities, such as USCINCPAC exercises Tempest Express, Tempo Brave, and Cobra Gold. Many organizations outside of I Corps fully support these exercises and the special conferences and planning sessions. Those participating in recent joint exercises include JTFCEM cells, USACE, NAVFAC, Contingency Real Estate Support Team (CREST), and LOGCAP personnel.

When I Corps calls a no-notice alert, personnel from JTFCEM, 35th Engineer Brigade, USACE, NAVFAC, and Brown and Root are notified to test telephone-alert procedures and determine how quickly they can report to I Corps. Additionally, JTFCEM and 35th Engineer Brigade reservists work on JTF SOPs, board procedures, operation plans, and contingency plans during training weekends and/or active training periods with the I Corps staff engineer section. Participation in these events helps integrate personnel from all organizations into a trained JTF engineer staff.

The Future

Joint engineer operations are a way of life now and will be in the future. Brigadier General Harty, then the Civil Engineer of U.S. Air Force, Europe, recently addressed a group of multiservice engineers who were revising USAEUR's engineering procedures. He stated, "Engineers will always somehow find a way to accomplish the mission. But do we always have to do it the hard way?"[5] Proper JTF staff planning now will help eliminate doing things the hard way in the future.

Lieutenant Colonel Langley is the Assistant Corps Engineer (Forward), I Corps. He has served in several joint assignments, most recently as the Contingency Engineer for U.S. European Command. A Command and General Staff College graduate, he holds a masters degree in systems management from the University of Southern California.

Endnotes

[1] "Joint Civil/Construction Engineer Training: Its a Reality." *Engineer*, December 1994, pages 2-17.

[2] "Jointness - Essayons," *Engineer*, August 1994, page 32.

[3] Joint Publication 4-04, *Joint Doctrine for Civil Engineering Support*, July 1995.

[4] Joint Publication 5-00.2, *Joint Task Force Planning Guidance and Procedures*, September 1991.

[5] Brigadier General John R. Harty, Ramstein Air Base, Germany, March 1991.

Engineer Problem

Immediate Action Procedures for Chemical or Petroleum Spills

When off-loading a 2 1/2-ton truck in the 6th Engineer Battalion's motor pool, Private First Class (PFC) Melcher dropped a 55-gallon drum from the tailgate. The impact caused the drum to rupture, spilling the entire contents on the asphalt. PFC Melcher did not know what was in the drum.

- What immediate actions should PFC Melcher take?
- Who should he notify?
- Because PFC Melcher is not familiar with the substance in the drum, what additional actions should he take?
- Where can he find the proper procedures to follow?

Engineer Solution is on page 45.

OPERATION DIAMOND DEMOCRACY

The United Nations Mission in Haiti

By Lieutenant Colonel Robert L. McClure

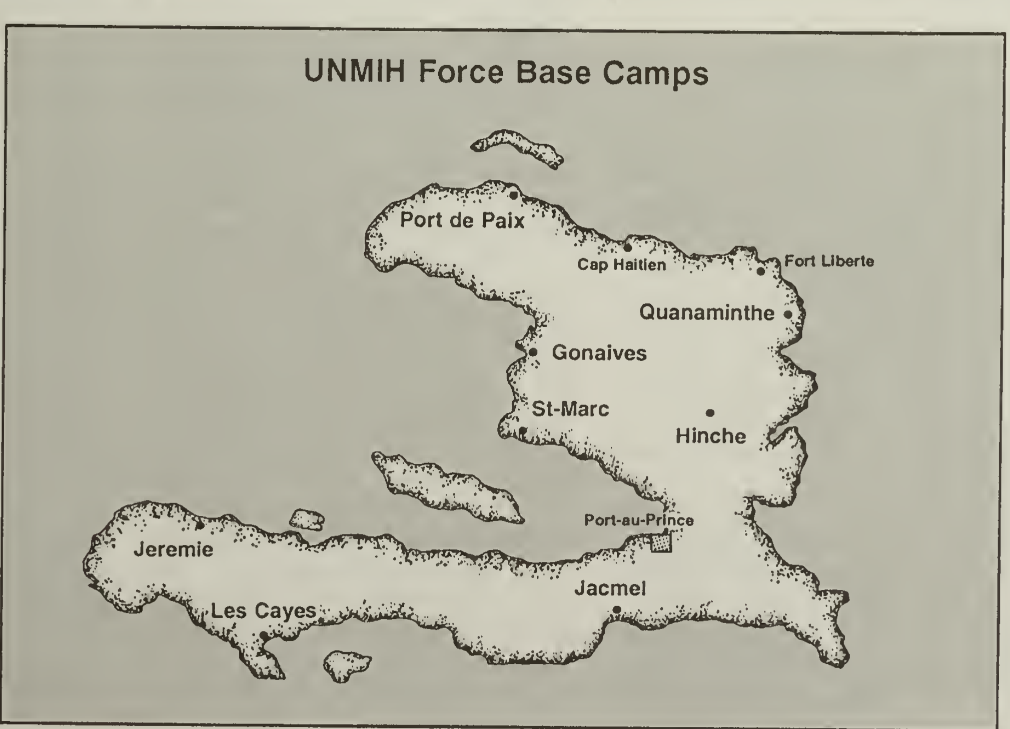
It is no surprise that the number of other-than-war deployments for engineers has risen dramatically in the past few years. One only need mention places like Somalia, Rwanda, Surinam, Panama, or Haiti to see how differently—and in how many directions—engineer forces are used in this new world order. Given that the overall Army force structure has shrunk dramatically since 1991, the likelihood of engineers deploying to almost anywhere has clearly increased. It is no longer a question of if, but when, the call will come for another engineer battalion to serve overseas in either a peacekeeping or a humanitarian environment other than war.

This article concerns one unit's experience—the 92d Engineer Battalion (Black Diamonds) from Fort Stewart, Georgia—as it deployed in support of the United Nations Mission in Haiti (UNMIH). In addition to explaining the mission, organization, and challenges encountered, we include lessons learned to benefit future deployments by other battalions.

Training for our forces is right on target, which means the individual American soldier is more than equal to any mission. However, commanders and staffs must be prepared for frustrations when dealing with outside agencies, such as the UN and other nongovernmental organizations. Not everyone is as efficient as the Army.

Deployment

In early February 1995, the 92d Engineer Battalion (-) was notified that it would deploy to Haiti within three weeks, where it would first be part of the multinational force and then transition to UNMIH on 31 March. The notation (-) is key here because we were asked to deploy a heavy engineer company, parts of the battalion staff, and the necessary support


UNMIH Force Base Camps

CAN-AM Engineer Battalion (Heavy)
UN Base Camp Status
As of 20 May 1995

Location	Command and Control	Personnel
	Battalion Camps	
Gonaives	US	410
Les Cayes	US	255
	Company Camps	
St-Marc	CAES	126
Jeremie	CAES	100
Jacmel	US	171
Quanaminthe	US	150
Port de Paix	CAES	100
Hinche	CAES	150

Figure 1

personnel; however, we were to keep the total number of personnel under 157. We essentially deployed pure, but we reinforced one vertical platoon with an extra squad and the horizontal platoon with an extra section of dump trucks and then added direct support maintenance from the headquarters and support company.

The Mission

UNMIH's mission is to provide a stable and secure environment throughout Haiti so that free elections, scheduled for this summer and fall, can take place. The engineer-specific mission is to build a series of base camps so that force presence can be maintained outside the large cities. Figure 1 shows the planned size and location of these camps.

Haiti's terrain is uninviting to say the least. Port-de-Paix and Jeremie cannot be reached by land with anything larger than a HMMWV. The journey to Jacmel requires crossing 3,000-foot mountains and, although Hinche and Gonaives are less than 100 miles from Port-au-Prince, the roads are so bad that convoys take more than 6 hours to reach them. Needless to say, the primary means of deploying construction equipment is by sea.

Can-Am Battalion

Along with the deployment order, we received instructions to form part of a combined engineer battalion with 108 Canadian soldiers once we were in theater. Unknown to me, but apparently decided several months earlier, the battalion staff was to be combined—the executive officer, the command sergeant major, the S1, and much of the S3 section would be Canadian. Figure 2, page 27, shows the battalion staff by position and nationality. The point is that political considerations often influence force structure decisions both operationally and tactically. This is not new by any means but is worth remembering. What I found interesting is that the Canadians had known, to a man, for more than six months who would deploy and that they would team up with an American unit. They just didn't know it would be the 92d. Once together, we formed what came to be known as the Can-Am Engineer Battalion and adopted the motto "Diamonds Ubique!"; the word "Ubique" being to Canadians what "Essayons" is to American Army engineers. The battalion symbol of a black diamond on a red maple leaf became our signature in Haiti.

The combined engineer battalion of Canadians and Americans performed extremely well. The Canadian unit was selected from across Canada and represented skills not normally found in our combat heavy battalion. The Canadian design team moved right into the S3 section and almost immediately began creating products that were of architectural- and engineering-firm quality. We developed a system where American surveyors (MOS 51T) visited and surveyed a proposed campsite, and in three days, Canadian and American staff members produced detailed blueprints and a complete bill of materials for the camp. At the soldier level, the fit was very complementary. The Americans were strong in theater-of-operations construction; the Canadians were more technically schooled in electrical distribution, waste water design, and fine carpentry. The engineer equipment mix was even better. We had bulldozers and other heavy equipment; they had "bobcat"-sized vehicles for smaller spaces. About the only difference was generational. The average age of the Canadian soldiers was 37, or about 15 years older than their

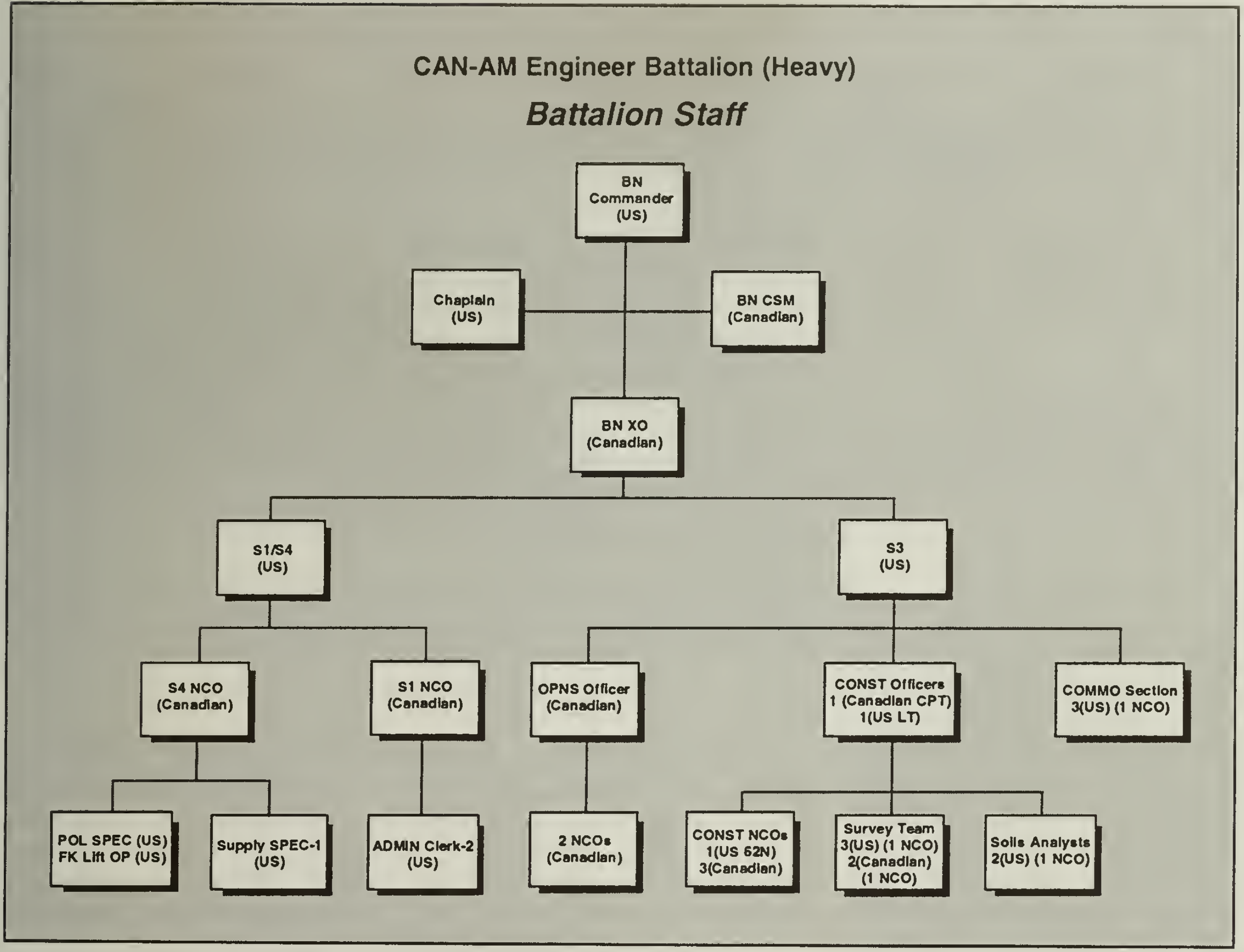

CAN-AM Engineer Battalion (Heavy)
Battalion Staff
BN Commander (US)
Chaplain (US)
BN CSM (Canadian)
BN XO (Canadian)
S1/S4 (US)
S3 (US)
S4 NCO (Canadian)
S1 NCO (Canadian)
OPNS Officer (Canadian)
CONST Officers 1 (Canadian CPT) 1(US LT)
COMMO Section 3(US) (1 NCO)
POL SPEC (US) FK Lift OP (US)
Supply SPEC-1 (US)
ADMIN Clerk-2 (US)
2 NCOs (Canadian)
CONST NCOs 1(US 62N) 3(Canadian)
Survey Team 3(US) (1 NCO) 2(Canadian) (1 NCO)
Soils Analysts 2(US) (1 NCO)

Figure 2

American counterparts. Of course, that allowed everyone to enjoy a wide range of music on the worksite!

Base Camps

Initial plans were for UNMIH to deploy forces to camps with medium-sized general-purpose tents, burn-out latrines, and "Aussie" showers, followed by hard shelters provided by the UN. Camp layouts required planning for electrical distribution from generators as large as 240 kilowatts and septic systems capable of supporting as many as 400 people.

In terms of engineering effort, building the base camps was not difficult. The challenge was to do so in a country with no reliable electricity or potable water and roads that often resembled the back side of the moon. The UN has a complete inventory of base camp structures that it moves around the world to support operations such as Haiti. They appeared in country soon after our arrival and were transported and erected by the Can-Am engineers—ablution units (showers, toilets and sinks), trailer-mounted kitchens with attached generators, and temporary living accommodations (manufactured by Nitco, a Southwest Asian company). Theoretically, some of these items only needed to be placed on-site and hooked up to either the electrical- or water-distribution system. That sounds easy, and it is if you've done it before. But the American Army has had little experience in deploying units on UN operations, so we were unfamiliar with the requirements. Additionally, each unit was wired for 220 volts and had to be rewired to fit the camp's 110-volt power system. We asked for help from almost everywhere and even received faxes from Egypt containing instructions for assembling Nitco trailers. In the end, it was one UN-experienced engineer talking to another on the ground that solved the mystery.

Realizing the importance of maintaining a complete set of the technical specifications for these UN units is a valuable lesson. I strongly recommend that a repository of UN construction information be kept at the Engineer School and given to units deploying on peacekeeping missions. Had we known what size PVC pipe was needed for the ablution units or the size and gauge of wire needed for kitchens, we would have ordered that material when we were alerted and saved weeks of waiting in country.

Photo by LTC Robert McClure

UNMIH base camp at Gonaives. The site was the town soccer field that had been abandoned to grazing goats.

The UN System

Another lesson has to do with the UN system itself. For this, one can't "learn" anything for the next deployment, only prepare for it. Quite frankly, the UN system is laborious and slow at best. For Army engineers accustomed to a total mission focus and a "get-it-done-yesterday" mentality, working with the UN can become a frustrating professional challenge. A major reason for this is the bureaucratic design of UN missions. Coequal with the UN military force commander is the chief administrative officer (CAO). He is charged with monitoring all operation expenses and handles contract bidding and purchasing for the entire force. No one in the military, including the force commander, can obligate or spend a dime without going through the CAO.

When I needed electrical wire, plywood, or other supplies for a base camp, I went through the supply officer (U4) to the CAO, where my request was sent out for competitive bids (a minimum of three, usually from the U.S.). The bids were then evaluated and awarded to the lowest bidder, who usually began delivery two weeks later—with no penalty clause for items delivered later than that. The entire process—from handing a base-camp order to the U4 until materials were delivered to Port-au-Prince—averaged from 6 to 8 weeks. The impact on the engineer was that reliable construction planning became almost impossible.

Students of bureaucratic politics will recognize an obvious divergence in goals here. The military and force commander define success as accomplishing the mission. In Haiti, accomplishing the mission meant maintaining a stable environment by pushing the force out to the countryside via base camps. Mission success for the CAO was defined as having

Photo by MAJ Rick Spearman

UN soldiers unload gravel at Gonaives. More than 6,000 cubic yards of gravel were hauled to cover the area around the base camp.

Photo by LTC Robert McClure

UN soldiers constructing floors for general-purpose tents.

the entire effort cost as little as possible. Given that, one can easily understand how seeds of frustration and misunderstanding can grow. Army engineers must be extremely flexible and creative when working within these constraints.

Making a Difference

Have we made a difference in Haiti? The answer is a resounding yes! While it is still too early to tell if democratic institutions have truly taken root, I am optimistic. In just the few months I've been here, the increase in economic activity (and the resultant traffic) is unmistakable. Civic violence has markedly decreased, and a country that has been unstable for years now knows stability. Engineers have contributed to that stability by building base camps and completing dozens of civic-action projects all over Haiti. Having to wait for materials allowed us time to help the Haitian people. We made school desks from scrap 2x4s, built footbridges from extra plywood, and repaired broken farm and other machinery. Projects like these and dozens more, initiated in conjunction with the local population, gave each soldier a reason to feel good. There was always worthwhile work to do.

The deployment of the 92d Engineer Battalion and its transformation into the Can-Am Engineer Battalion is unique but is probably an indication of things to come. Engineers will surely continue to support UN peacekeeping and other nation-building missions. Whether they deploy pure or combined with allies remains to be seen. The important thing is to be ready, for deployment time will come.

Lieutenant Colonel McClure is commander of the 92d Engineer Battalion at Fort Stewart, Georgia. During the 1995 deployment to Haiti, he commanded the Can-Am Engineer Battalion as a part of UNMIH. Previous assignments include S3 and XO, 23rd Engineer Battalion; Commander, 42d Engineer Company, Berlin Brigade; and Commander, E Company, 12th Engineer Battalion, all in Germany. He holds a master's degree from Harvard and is a registered professional engineer in Virginia.

Commander's Notebook

Additional topics concerning the 92d's recent deployment to Haiti are addressed below:

Logistical Civil Augmentation Program (LOGCAP). The UN administers a general LOGCAP contract for the joint engineer force. During most of our time in Haiti, the UN continued a "bridge" contract with Brown and Root Services Corporation while actively searching for an alternate provider. Contingents were free to request additional services from the contractor if they paid for them. For example, while the UN paid Brown and Root to provide Class I supplies to all contingents, it was the contingents' responsibility to prepare and serve the food. The U.S. contracted with Brown and Root to prepare food for American units, while the Canadians in Port-au-Prince cooked their own food. Our Can-Am group cooked out of field kitchens at the construction sites, sometimes combining cooking staffs.

Command and Control. My command relationship with the Canadian engineer squadron was that of operational command (OPCOM). While I could task organize, assign missions, and give policy guidance to everyone in the battalion, disciplinary and evaluation actions remained a national responsibility.

Equipment. In retrospect, I should have left the 9-wheeled rollers in Georgia and taken the concrete mobile trucks. I was promised an additional vibratory roller in country; it never appeared, and the one I brought became indispensable.

HMMWV. The HMMWV is the single most outstanding piece of equipment the Army has purchased in the past 20 years.

Communications. Tactical satellite communications were essential because distances between base camps far outstripped FM capability. I had four sets, which was the minimum required for this mission.

Air Force Civil Engineers:

Building Air Power's Foundation

Dr. Ronald B. Hartzer

Joint activities are changing the way military engineers train, acquire and use equipment, and support contingency operations. An understanding of the engineering function of all services is necessary because each service performs their missions differently. The basic difference between Air Force civil engineers and their counterparts is inextricably tied to the Air Force mission: To defend the United States through the control and exploitation of air and space.

Air Force units are mobile to project power worldwide, and they fly and fight from fixed bases. Therefore, Air Force military engineers have an overlapping peacetime and wartime mission: To provide, operate, maintain, restore, and protect the installations, infrastructure, facilities, housing, and the environment necessary to support air and space forces having global reach and power across the range of military operations. The same engineers who operate and maintain bases in peace must also expand, recover, and restore them in war. This article explores how Air Force engineers have supported air power in the past and how that experience has led to their present mission.

Air Force civil engineers have a proud heritage that began before World War I. The engineering function originally was a small unit of the Army Signal Corps, and construction was handled through the Office of the Chief Signal Officer. When the Air Service was established in 1918, the Building and Grounds Branch of the Division of Military Aeronautics inherited maintenance and construction responsibilities, in conjunction with the Construction Division of the War Department, for ten flying schools, five balloon schools, and one repair depot. In 1921, construction of Air Service projects was turned over to the Construction

Service of the Quartermaster Corps, which worked closely with the Air Service Building and Grounds Office. Throughout the 1930s, the Air Service (known by then as the Air Corps) slowly continued to expand. The availability of Works Progress Administration funds facilitated construction that otherwise would not have been possible. In 1940, construction of Army Air Corps facilities in the United States was transferred to the Corps of Engineers.

World War II

Long before Pearl Harbor, the continual growth of the Army Air Corps indicated a vital need for engineers specialized in building airfields overseas to support tactical and strategic air operations. The Air Force needed its own engineers—troops who trained with it, spoke its language, and understood its requirements. These men should be trained and equipped to rapidly construct advanced airfields close to or behind enemy lines. They also should be trained to improve and maintain existing facilities, camouflage airfields, and construct defensive works. The engineers needed to be organized and prepared to repair airfields damaged by enemy bombing. And finally, with trained riflemen and machine gunners, they must be prepared to actively defend their airports. The concept of the aviation engineers was troops trained to construct, conceal, maintain, and defend airfields.

In 1940, a handful of officers and 80 enlisted men assembled at Fort Benning, Georgia, to form the 21st Engineer (Aviation) Regiment. They were the first of more than 100,000 aviation engineers who served in World War II. To protect themselves from air and ground attacks, the aviation engineers were trained and equipped for combat as well as construction.

In addition to the regular aviation engineer battalions, 16 airborne aviation engineer battalions were organized. These specialized units were designed to parachute in ahead of other airborne troops, patch up captured airfields or construct new ones with hand tools, and then be reinforced by glider-borne engineers carrying light equipment.

During most of World War II, the maintenance and repair of Army Air Force installations were performed by general service engineers called *post engineers*. At the end of the war, 1,435 airfields located in 67 countries had been used, built, or improved by or for the Army Air Force.

When the Air Force became a separate service in 1947, its construction continued to be programmed and budgeted by the Army Corps of Engineers. The Air Force civil engineer function operated as the Directorate of Installations under the Deputy Chief of Staff, Materiel. At the base level, the Air Installation Officer was responsible for repairing and

A bulldozer operated by an aviation engineer clears a hardstand area for Boeing B-29 Superfortresses on Guam, 24 March 1945.

maintaining facilities, grounds, and utilities. Fire protection and aircraft crash rescue were added.

Korean War

The Korean War presented tremendous challenges for Air Force engineers. Troop construction and bomb damage repair to Air Force facilities were accomplished by Army engineer battalions under the direction of the Air Force. They were known as special category Army personnel with the Air Force (SCARWAF). Air Installation Officers were responsible for normal maintenance and repair at Air Force installations.

During the period between World War II and the Korean War, several new aircraft were introduced into the inventory. The new aircraft required longer and wider runways, larger taxiways and parking aprons, and more stringent design criteria for gradients, clear zones, and pavement thickness. Larger fuel storage and munitions facilities, as well as more maintenance and support facilities, were needed. Engineers worked to accommodate ever-larger cargo aircraft and jet fighters by constructing 9,000-foot all-weather runways at Osan, Taegu, Kunsan, and Suwon. Constructing an airfield during World War II was expressed in terms of battalion days or weeks. During the Korean War, the effort was expressed in battalion months.

A Professional Force

The 1950s were a period of significant growth in Air Force basing. The elevation of the Directorate of Installations to Assistant Chief of Staff level was indicative of the increased engineering activities related to the massive strategic forces buildup, the intercontinental ballistic missile design and construction program, the early warning system construction, and the construction of the U.S. Air Force Academy. Air Force engineer leaders stressed professionalism. The Air Force Director of Installations was renamed the Director of Civil Engineering; and at the base level, Air Installation Officers became Installation Engineers and finally Civil Engineers.

During this period, the Air Force requested permission to organize its own combat engineering function and transfer the 30,000 SCARWAF engineers from the Army to it. However, the Secretary of Defense decided to leave the engineers with the Army and abolish the SCARWAF units, so the Air Force was without its own combat engineers until the mid-1960s.

The Lebanon Crisis of 1958, the Berlin Crisis of 1961, and the Cuban Missile Crisis of 1962 demonstrated a need for mobile civil engineer teams that could immediately deploy to perform construction work during emergencies. Prime Base Engineer Emergency Force (BEEF) teams were created to fill that need. A more long-term, heavy construction and repair requirement also existed to support the rapid force buildup in Southeast Asia. The solution for that requirement was the Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer (RED HORSE).

Prime BEEF. The basic concept was to take engineers who operated and maintained bases in peacetime and train and equip them to respond to contingency situations in support of air power around the world. This emergency force included both recovery and mobility forces. The primary mission of the recovery teams was to provide a minimum force of highly skilled military civil engineers at each air base to maintain essential operation and maintenance services during and immediately following enemy attack, major disasters, and other emergencies. The mobility forces were to respond to unforeseen contingencies or special warfare operations, with their missions depending on the nature of each team. Their first big opportunity came in Southeast Asia.

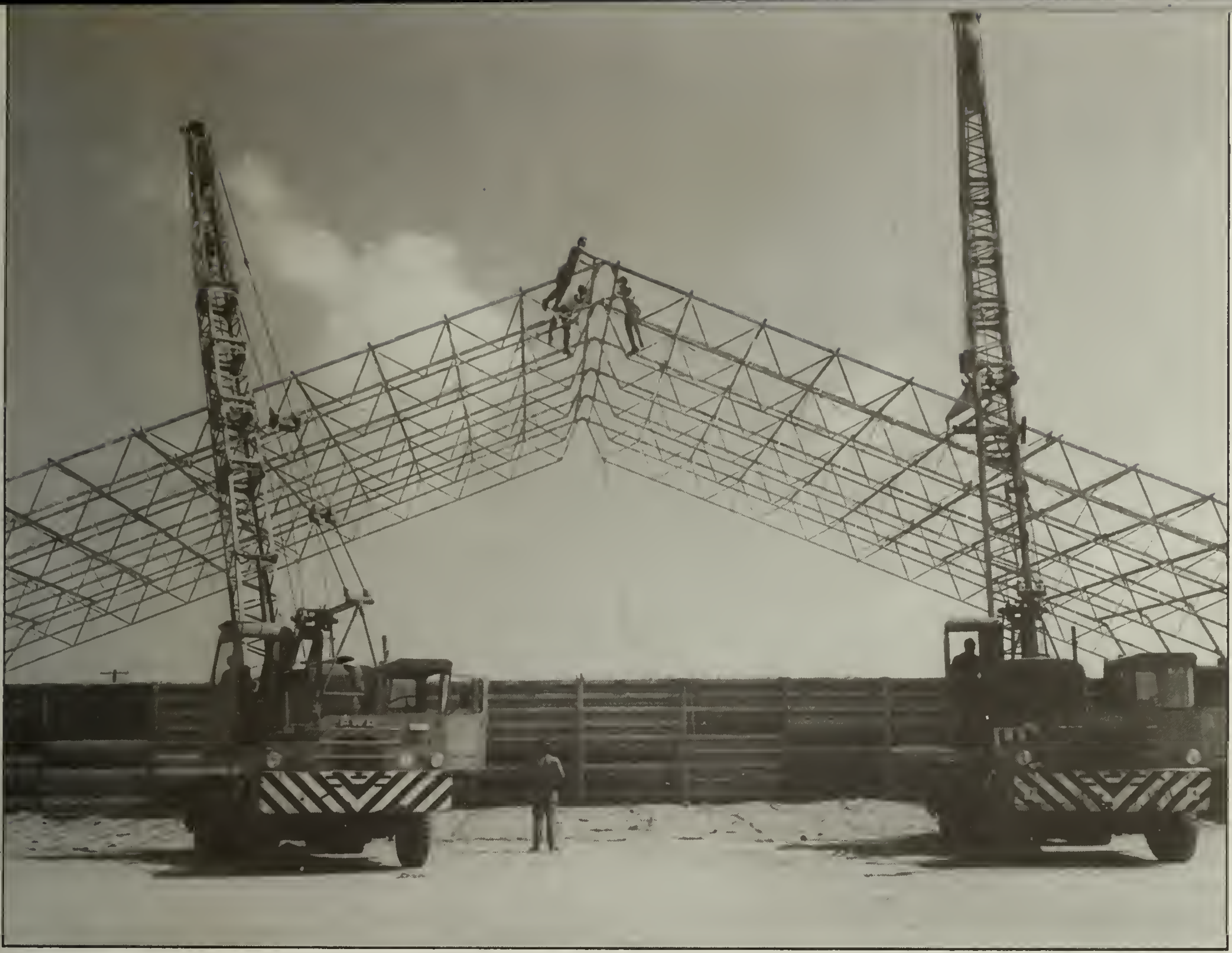
In the early days of the Vietnam War, large numbers of Air Force strike aircraft were deployed to bases where pavement for aircraft parking was at a premium. Aircraft were parked wingtip to wingtip and were vulnerable to an accidental explosion or enemy attack. When a bomb accidentally exploded at Bien Hoa Air Base in May 1965, the resulting explosions destroyed 40 unprotected aircraft and killed or injured more than 100 people. Because the Air Force was unable to obtain needed engineer support from the heavily committed Army, three CONUS-based, 28-man Prime BEEF teams deployed to construct revetments at Bien Hoa, Tan Son Nhut, and Da Nang. These teams provided protection for combat aircraft and, more significantly, they validated the Prime BEEF concept. Wartime necessity had given Air Force civil engineering a warfighting capability. By 1968, more than 1,600 personnel from nearly 60 Prime BEEF teams had responded to support facility requirements in Southeast Asia.

RED HORSE. Six RED HORSE squadrons were organized and deployed to Southeast Asia by November 1966. Each squadron was a self-contained unit of 400 men with a variety of skills and construction equipment to provide combat engineering support to Air Force tactical units in theater. They performed major construction on several bases and completed much of the vertical work left undone by contractors.

Peacetime Missions

As American involvement in Southeast Asia wound down, RED HORSE capabilities were maintained at a high level of readiness. For the first time, the Air Force had organic heavy-repair units designed for contingency support with no contingency at hand. In an effort to provide an engineering heavy-repair capability as responsive as the tactical aircraft they supported, the Air Force developed a program to teach skills similar to those required during a contingency. Civil engineering projects were the basis of this training.

Disaster Relief. Air Force engineers have often assisted communities recovering from natural disasters. In 1972, Prime BEEF and RED HORSE teams helped in search, rescue, and recovery operations following severe flooding in Pennsylvania and South Dakota. When a tornado devastated Xenia,


U.S. Air Force photo

Members of the 819th civil engineering REDHORSE squadron connect beams on a building under construction in Tuy Hoa Air Base, South Vietnam in January 1970.

Ohio, in 1974, engineers and firefighters from nearby Wright-Patterson Air Force Base assisted in the cleanup and helped extinguish fires caused by gas leaks. In 1979, the 823rd RED HORSE squadron assisted in recovery operations at Keesler Air Force Base, Mississippi, which was heavily damaged by Hurricane Frederick. More recently, Air Force engineers assisted in recovery efforts following Hurricanes Hugo and Andrew.

Environmental Protection. Protection and restoration of the environment became a major concern for Air Force civil engineers in the 1970s, when they assumed responsibility for the Air Force environmental protection program. New terms became part of the everyday language for Air Force engineers—environmental impact statement, installation restoration, and pollution abatement.

Training. In 1979, the Air Force Engineering and Services Center opened a training facility at Eglin Air Force Base, Florida. Their mission was to provide hands-on training to Prime BEEF team members on rapid runway repair, bomb damage repair, force bed-down, bare base equipment, chemical warfare defense, and explosive ordnance reconnaissance in a realistic contingency environment. In 1985, base recovery after attack training (BRAAT) was initiated. This interdisciplinary training explains how individual functional areas interface for a coordinated recovery effort. In 1994, the training moved to the Silver Flag Exercise Site at Tyndall Air Force Base, Florida.

Readiness. The 1980s were a period of challenges for Air Force Engineering and Services personnel as engineers worked on projects overseas. Managing the overall construction program for two Israeli air bases in the Negev Desert was one project that presented special challenges because of the foreign construction standards and criteria and a demanding construction schedule.

In June 1986, Prime BEEF teams from nine major commands, the Air Force Reserve, and the Air National Guard met at Eglin Air Force Base for the first Readiness Challenge. The 25-person teams competed in seven events: vehicle operations, conventional protection, rapid runway repair, minimum operating strip selection, manual damage assessment, chemical warfare defense, and force bed-down. The competition now includes other Air Force personnel as well as the Canadian Air Force engineers. Readiness Challenge V was recently completed at Tyndall Air Force Base with the U.S. Air Force Academy team winning the overall competition.

Air Force civil engineers construct an ammunition storage area in Saudi Arabia during the Gulf War.

Gulf War

Air Force civil engineers were among the first engineers to arrive in theater to support Operation Desert Shield/Desert Storm. Prime BEEF teams immediately began bedding down aircraft and personnel at sites across the region. While some bases featured modern facilities, others had little more than a runway, a parking ramp, and sand. Often they constructed tent cities with bare-base equipment, such as the Temper tent and general purpose shelter, which were powered by 750-kilowatt mobile generators. When potable water was not available, engineers processed water through reverse osmosis purification units. Within days, they constructed living and working facilities and utilities for a formidable show of air power.

When Iraq invaded Kuwait, RED HORSE was ready to respond, and the Air Force soon had a strong engineering capability in theater. They broke into teams and completed more than 25 construction projects at 12 sites throughout the region. Projects included an ammunition haul road near Dhahran for the Army and a K-Span facility for the Marines.

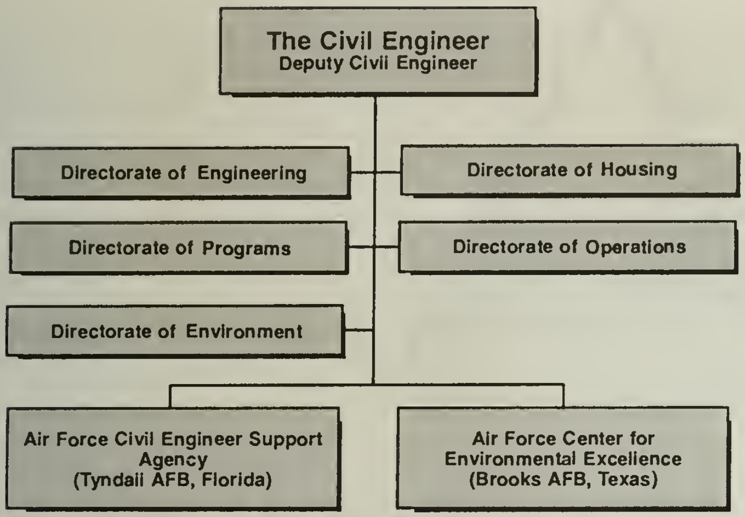
Construction of the Al Kharj Air Base was a major project. Facilities for more aircraft were needed closer to the Kuwaiti border, so a new base was planned at Al Kharj, about 60 miles south of Riyadh. The base had been identified as a massive Saudi military installation, but only a runway, a taxiway, and a parking apron had been constructed. RED HORSE, Prime BEEF, and contractor personnel compacted more than 200,000 cubic yards of red clay to serve as the foundation for a tent city. Eventually, 630 Temper tents, 4 kitchens, a gymnasium, 21 latrines, and 26 shower-and-shave units were erected. The engineers also constructed a sanitary system and a power plant, assembled an air-transportable hospital, and built six K-Span structures. RED HORSE also constructed a theater munitions storage area at the base. Al Kharj was ready for aircraft early in January, and by the beginning of the war, the base was home to 4,900 Air Force personnel.

RED HORSE engineers soon undertook larger and heavier jobs, such as parking ramps and taxiways. Shortly before the cease fire, a joint RED HORSE/explosive ordnance disposal team tackled their most challenging postwar project—to deny Tallil and Jaliba Air Bases in southeastern Iraq to future use by returning Iraqi forces. At Tallil, engineers used approximately 80,000 pounds of explosives, consisting primarily of 40-pound shape charges and MK-82, 500-pound bombs, to make cuts in the runway and taxiway. At Jaliba Air Base, they made 27 cuts in the pavement to deny a concrete runway and two parallel asphalt taxiways.

During the Gulf War, Air Force civil engineers supported the entire Air Force in one of the greatest military victories in American history. More than 3,000 engineers bedded down 55,000 people and 1,200 aircraft at nearly 30 sites. They erected 5,000 tents and constructed buildings totalling 300,000 square feet. Air Force engineers demonstrated that they can provide a good living and working environment to support the projection of air power around the world.

Operations Other Than War

Since the end of the Gulf War and the Cold War, significant changes have occurred in the size, structure, and mission of the American military. For Air Force civil engineers, the 1990s have brought many deployments around the world to support military operations other than war. After returning from the Gulf War, Air Force engineers deployed to Turkey and Iraq to help feed Kurdish refugees during Operation


The Civil Engineer
Deputy Civil Engineer
Directorate of Engineering
Directorate of Housing
Directorate of Programs
Directorate of Operations
Directorate of Environment
Air Force Civil Engineer Support Agency (Tyndall AFB, Florida)
Air Force Center for Environmental Excellence (Brooks AFB, Texas)

Provide Comfort. They constructed and maintained several base camps for the joint and combined forces operating in the region. Both Prime BEEF and RED HORSE personnel participated in Operation Restore Hope in Somalia. In addition to completing projects at Mogadishu, the engineers constructed 2.4 linear miles of revetment to protect Army aviation assets, including Blackhawk and Cobra attack helicopters. More than 1,000 engineers currently are deployed to Haiti, Guantanamo Bay, Bosnia, Kuwait, and Saudi Arabia to support military, peacekeeping, and humanitarian operations.

Today's Challenge

At the Air Staff, the civil engineer answers to the Air Force Chief of Staff. He is responsible for organizing, training, and equipping the 50,000-person civil engineering force and for the development, construction, maintenance, and environmental quality of Air Force bases worldwide. He also oversees two field operating agencies-the Air Force Civil Engineer Support Agency at Tyndall Air Force Base and the Air Force Center for Environmental Excellence at Brooks Air Force Base, Texas (see chart above).

Air Force civil engineers continue to support the readiness and quality-of-life enhancement for all Air Force members. For example, they provide high-quality, contemporary homes for Air Force families. In conjunction with the other services, they are developing a new construction standard for dormitories that features private living/sleeping rooms and shared bathrooms and kitchenettes. This new construction standard will greatly increase the quality of life and provide much-needed privacy for all unaccompanied personnel.

After the 1995 base closure decisions are made, the engineers will work to rebuild the Air Force's capital investment budget and make better use of technology. They will strive to lower the cost of cleaning up hazardous waste sites and sustain the air base in spite of reductions in the civilian work force.

An important challenge for today and tomorrow is "jointness." Standardization of equipment and operating techniques among the services will save both time and money. Experience has shown that all services can achieve greater effectiveness through joint initiatives such as the Interservice Training Review Organization. Joint training provides a better perspective of each service's engineering strengths and missions. By training together, engineers will be ready and able to fight together whenever the time comes.

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(Personal Viewpoint, continued from page 19.)

assuming mastery of the electromagnetic spectrum. And we're not hardening for electromagnetic pulse any more. It appears we're practically asking an enemy to do something dramatic.

Strategically, the situation may be even worse. An article in the June 12-18 issue of *Defense News*, titled "Information Warfare Sparks Security Affairs Revolution," describes cyberspace war: "without a shot being fired by wrecking a nation's information infrastructure, including military, banking and telephone systems, power grids and computer networks." Furthermore, according to Vice Admiral Arthur Cebrowski, director for command, control, communications, and computers on the joint staff, "the United States is extremely vulnerable to a cyber-attack." Vindication for the Wizards!

Security from cyber-attack is a formidable task facing us. Other technical problems such as software and connectivity may prove to be easier to fix than I envision. My observation is that we tend to suffer for a long time with some poorly designed systems. Bad software and shaky connectivity! The solution goes far beyond just using consistent commands for common functions. My nightmare is a battlefield system like the PROFS message system we've struggled with for so long.

The opportunities of informational warfare deserve the enthusiasm they're getting. Criticism, however constructive, is regarded as "Luddism" and "flat-Earthism." I believe that we need to turn over some Force XXI rocks! We are less-than responsible if we do not think things through!

Jeb Stewart is an analyst for the U.S. Army Engineer School. A graduate of Virginia Tech, he has a Master of Science degree in Defense and Strategic Studies and is a graduate of the Command and General Staff College and the Army Management Staff College.

Dynamic Improvements at the National Training Center

By Major Tom Buning

The National Training Center (NTC) at Fort Irwin, California, is changing to meet the training and leadership needs of the Army's CONUS-based heavy divisions. Clearly the Army's eye is on the future: The framework for Force XXI is outlined and a new experimental force within the 2nd Armored Division at Fort Hood, Texas, is being organized. Training, however, is still based on the reality that our go-to-war divisions must fight current doctrine, organizations, and equipment. Faced with the need to more fully train the entire brigade combat team (BCT) in the art of armored maneuver warfare, the NTC is implementing some significant changes.

In today's smaller, CONUS-based, power-projection Army, the BCT is likely to conduct limited independent, tactical-level operations. The NTC has revised the vehicle for training this critical element of our force based on an assessment of the Army's program for training warfighting commanders. The Army's structured Combat Training Center program allows for comprehensive training at the task force level and below. Brigades deploy to the NTC for 14 days of intensive training. The previous requirement to rotate battalion-sized task forces through the live-fire phase meant that an entire brigade with all subordinate task forces trained together for only 3 days during the last two missions. The Battle Command Training Program (BCTP), based at Fort Leavenworth, Kansas, conducts the warfighter exercise program to train corps and division commanders and their staffs. They conduct simulated combat using computer-driven exercises against an uncooperative enemy. In the overall training strategy provided by the CTCs, the shortfall of greatest concern to our warfighting commanders is the need to improve the brigade commanders' ability to fight and maneuver their forces.

Based on the objectives of heavy division commanders in FORSCOM, the NTC has developed new scenarios that enhance training realism and emphasize the importance of brigade operations. We have changed everything from the Operations Group training METL to scenario development.

July 1995's Rotation 95-10 will initiate a new program that features full-up brigade-level operations. Now the brigade will provide command and control for its major subordinate commands through 6 days of live-fire and 8 days of force-on-force training. These changes are designed to complement the comprehensive training focus provided by the task force observer/controller training teams.

The most critical changes to brigade operations training are in the live-fire phase. New targets in the live-fire training area will allow the entire BCT to participate in offensive and defensive maneuvers. (The terrain and lack of essential targets previously limited training to one mechanized battalion-sized task force at a time.) Now brigades will fight as a team to put steel on target to destroy an entire Krasnovian Division.

When brigades conduct live-fire maneuvers, safety considerations escalate. Starting in October 1995, new NTC trainers will attend a full program of instruction at the newly created Observer/Controller Academy to satisfy the increased safety requirements. At this academy, NTC trainers will verify their understanding of both the rules of engagement (ROE) and the safety considerations inherent in brigade-level live-fire operations. The live-fire training team, the Dragons, will be reorganized to provide complete training coverage for two task forces. The Dragons retain overall responsibility for training because they have extensive knowledge of the terrain, targets, weapons, and maneuver safety. For continuity and comprehensive training at all levels of the engineer unit's command and staff, the Sidewinder Combat Engineer Battalion Training Team will provide training coverage to engineer battalions through both the live-fire and force-on-force phases.

Command and control of the player units also take on a new dimension. A brigade probably will stay under the control of the 52nd Infantry Division throughout the rotation. This change creates a training opportunity for Operations Group planners to replicate division command and control cells, such as establishing a division tactical command post (DTAC). The DTAC will provide tactical battlefield command and control and increase the brigade's ability to realistically train the BCT's reporting and coordination requirements to higher headquarters.

NTC trainers may employ available technology such as distributed training using either video teleconferencing or the teletraining network (TNET). This capability provides an opportunity to train future leaders using a "classroom without walls" interface between TRADOC schools and NTC trainers. Preliminary planning now underway will determine the potential for conducting a command post exercise during each NTC rotation for key leaders in the brigade's third task force. Fighting as adjacent units on the same NTC terrain, against the same opposing force, the third task force's command and staff will execute their portion of the brigade mission through a computer-aided battle simulation.

Under the new program, division commanders assume a key role in determining the training goals and objectives for their unit's NTC rotation. The process is finalized when a division commander approves the scenarios written by the Operations Group planners for his brigade's upcoming rotation. The division's engineer brigade commander and staff have the same opportunity to provide training scenario input for their engineer battalion's rotation. The Sidewinders will work closely with the engineer brigade and battalion commanders as they prepare to deploy the battalion to the NTC. Together they will identify the mission-essential tasks that the commanders want to emphasize during the rotation. The Sidewinders then will focus on observing the performance of those tasks throughout the rotation and provide requested feedback. If the battalion's input is received early enough, it can affect development of the exercise scenario.

For the July rotation, the Sidewinders will bring on-line the communications equipment needed to replicate an engineer brigade headquarters. Use of that equipment will reinforce the requirement for engineer battalion command posts to report and coordinate with their higher engineer headquarters.

The end result of these changes is focused and realistic training. A brigade combat team will be introduced to the changes in the NTC experience during the unit's train-up. To more fully prepare the entire team's command and staff for an NTC rotation, both the quality and scope of the former FORSCOM Leaders Training Program have been changed dramatically. Renamed the Leaders Training Program and moved under the NTC's Operations Group, it is now a 6-day course that is conducted about 120 days prior to the rotation. As many as 75 members of a unit's team may attend the intense, command-tailored session. Billeted and fed at Fort Irwin, the unit conducts orders drills, executes a JANUS battle simulation computer exercise, and observes NTC battles and after-action reviews. NTC observer/controllers serve as primary instructors and coaches through both the core training and the optional electives selected by the commander.

From an engineer perspective, the conversion to brigade operations provides an excellent opportunity for the engineer battalion commander to fight his units on the battlefield. Now the main effort can be weighted through a task organization of critical engineer assets. The assets remain two line companies, a headquarters and headquarters company, and a platoon slice from a combat support equipment company that includes D7 dozers.

During some rotations, the brigade may also receive Reserve Component engineer digging assets for limited operations. Management of these assets will provide ample opportunity to test the battalion's command and control and planning processes. How well the battalion meets this challenge under the stressful conditions of realistic simulated combat operations will determine if they need more coaching or additional doctrinal training. The bottom line is that engineer battalion commanders and their senior staff who return to troops for the first time in an engineer restructure initiative (ERI) battalion will be more fully trained to fight the new organization. The upgraded NTC training will force them to use their dedicated battalion staff to effectively plan and synchronize engineer activities and effects on the battlefield.

Other recent initiatives also affect training at the NTC:

- The NTC opposing force (OPFOR) is fighting new doctrine! TRADOC PAMs 360-12 through 360-17 provide interim guidance until a new FM 100-60, *Opposing Force*, series is fielded. In accordance with a TRADOC memorandum dated 13 March 1995, the FM 100-2 series should no longer be used to develop training. The OPFOR now has capabilities-based doctrine, tactics, and organizational design. As a result, they can replicate the full range of operational threats that demonstrate greater levels of initiative and agility. The new doctrine describes the baseline threat that will be used in all Army interactive simulation programs.
- SAWE/MILES II is on board and begins operating with the July 95 rotation. Combat systems

on the NTC battlefield now are monitored with a GPS-based tracking system. Personnel and vehicle vulnerabilities to direct and indirect fires and surface area weapons are simulated using up-to-date technology. Computers assess casualties resulting from direct fire, indirect conventional weapons, chemical weapons, and both indirect fire-delivered and ground-emplaced mines. (See *Engineer*, April 1995, page 58.)

- An interim ROE manual will be distributed in July 1995 to units scheduled for upcoming NTC rotations. It includes all previous changes and is updated for use with the SAWE/MILES II training aids. Mass distribution of a final ROE manual is scheduled for distribution in the first quarter of FY96.
- The Armored Vehicle Launched MICLIC (AVLM) has been approved for use at the NTC. The Army Materiel Command has type-classified and issued the approved design criteria for a mounting device that allows the MK155 MICLIC launcher to be mounted on the armored vehicle launched bridge (AVLB) M48A5/M60 chassis. Procedures for the fabrication, installation, and use of the AVLM mounting device are described in Change 1 to Technical Manual (TM) 9-1375-215-14&P, dated December 1992. The change was distributed 30 June 1995. Mr. Michael Dawson, the point of contact, may be reached at (309) 782-1521 or DSN 793-1521.
- An article describing the mission and assignment policy of the Sidewinder Combat Engineer Training Team will appear in a future issue of the Engineer Officer Bulletin.

The NTC is implementing these changes with one goal in mind: Orchestrating the training rotation into a positive event that ultimately prepares the brigade combat team to more effectively conduct well-planned, synchronized combat operations. Meeting this goal fulfills the NTC philosophy of focusing and directing change rather than reacting to it. Future changes in force structure, size, and equipment are inevitable. In anticipation, NTC stands ready to lead the way in training the force.

Major Tom Buning is the engineer battalion S3 trainer at the National Training Center, Fort Irwin. Previous assignments include battalion S3, 5th Engineer Battalion, and more than 28 months of company command in the 23rd Engineer Battalion, including a 6-month deployment for Operation Desert Storm. He is a graduate of the Command and General Staff College and holds a master of science degree in engineering management from the University of Missouri, Rolla.

CTC Notes

Engineer is pleased to initiate a new department that focuses on the Army's Combat Training Centers. Our intent is to promote communications among the CTCs, the Engineer School, and the engineer force. We invite your comments and suggestions regarding this or other magazine departments.

Battle Command Training Program

Trends from recent warfighter exercises:

Obstacle Command and Control.

- The doctrine in FM 90-7 is good, but many units do not use the manual.
- Recording, tracking and disseminating enemy obstacles are problems for all divisions and corps. The biggest problem is that many units lack an assigned staff engineer (Field Artillery, Air Defense Artillery, Signal, etc.). Many engineer brigades are developing databases for use on a tactical Local

- Area Network (LAN) to record and track obstacles. The next step is to develop the discipline needed to check with the staff engineer of the maneuver unit that owns the terrain. The staff engineer can verify obstacle locations and lanes through them.
- Many divisions do not plan for obstacle control during offensive operations. They should war-game to identify obstacles needed to defeat enemy counterattacks or flank attacks and to protect the flanks of a penetration. On order, they should incorporate obstacle zones into the plan based on results of the war game.

Scatterable Mines. Engineers often fail to utilize the capabilities of scatterable mines. Many corps commanders place tight controls over the use of scatterable mines (i.e., require commander approval) but place conventional mines anywhere within approved obstacle zones. Reliance on conventional mines hurts the engineers' ability to rapidly emplace a defense or to add depth to the defense. One division's good technique for exploiting the capabilities of scatterable mines was to tie their counterattack to the expiration times of their scatterable minefields. The corps delegated authority to emplace mines to the division commander, who delegated the use of 48-hour ground-emplaced Volcano mines to the maneuver brigade commanders. Phase lines were used to establish times when specific obstacle zones could be cleared of scatterable mines. Engineers used a combination of 4- and 48-hour scatterable mines to create an obstacle that cleared itself as the counterattack moved forward.

Intelligence Preparation of the Battlefield (IPB). Engineers at all levels must participate in the IPB and be the expert on enemy engineer capabilities. They must apply engineer knowledge of the terrain to template enemy engineer activity and continuously update the template as enemy engineer units are identified. Engineers must influence the targeting of enemy engineers. One unit identified specific enemy engineer systems for targeting and published a "WANTED" poster to help get their point across. That unit effectively prevented the enemy from fully installing his defense.

Joint Readiness Training Center

Engineer Strengths. Engineers continue to perform individual tasks to standard. Both sappers and heavy equipment operators are proficient at all skill level 1 tasks.

The following engineer proficiencies need emphasis:

Combined Arms Route-Clearance Operations. Recommend that all soldiers take mine awareness training. Modify the SALUTE report format to report obstacle intelligence. Develop and use an enemy obstacle marking standing operating procedure (SOP). Conduct route clearance as a combined arms operation.

Combined Arms Obstacle Integration. Recommend that units conduct leader training on echelons of obstacle planning. Develop a situational obstacle planning and execution SOP. Conduct mine supply operations using mine dumps or battalion Class IV/Class V supply points. Emplace linear obstacles as well as point obstacles.

Combined Arms Breaching Operations. Recommend that units apply the five breaching tenets to all breaching operations. Conduct a reverse planning sequence. Conduct full-force breach rehearsals. Implement a training program for combined arms breaching operations.

Engineer Battle Tracking/Reporting. Recommend that units revise engineer tactical command post (TAC) SOPs. Develop tactical operations center (TOC) charts and displays for mission-essential information. Use all communications systems available within the task force.

TOC Operations:

Integrating the Engineer Operations Cell Into the Battalion Task Force TOC

By Captain Thomas L. Sands, Jr.

No one likes to admit that he enjoys the tactical operations center (TOC). In fact, most people avoid it at all costs, especially when an orders process or a rehearsal is in full swing. I must confess that, as an engineer company executive officer (XO), I felt more comfortable taking care of maintenance, logistics, and other operations with a hands-on approach. At least that was my reasoning as I roamed the National Training Center (NTC) battle areas in my HMMWV, far from the task force TOC. Fortunately the observer-controllers (OCs) pointed out, in no uncertain terms, the doctrinal error of my ways. The exact quote was "The TOC is broken." Everything from shift manning to reports processing was dysfunctional; we inefficiently served the engineers and the maneuver force.

I was able to make up for my mistakes when I returned to the NTC 11 months later. Between rotations I changed from a combat XO to a plans officer. I came to appreciate the challenge of maintaining a solid, functional company TOC within the framework of the maneuver task force TOC.

Within the TOC, the engineer plans cell integrates into the maneuver TOC and its associated staff members, the higher engineer unit, and the engineer company for combined support of the maneuver task force. This service is no small task for two or three noncommissioned officers (NCOs), a driver, and a lieutenant. As the plans officer, the XO supervises his unit, and he must forge a working relationship with the supported task force's TOC. Together, the TOC crew, the XO, and the maneuver staff influence the creation of future plans and the

The engineer company TOC APC is plugged into the task force TOC complex.

effective execution of engineer operations. In this article, I will review the latest doctrinal information, as I saw it at the NTC, pertaining to the duties of the XO, the operations NCO, and the TOC crews, and their combined efforts to oversee the execution of the plan.

The battle captain and engineer company plans officer (XO) confer.

Executive Officer

The field XO has to shed the active, jack-of-all-trades garrison role and adapt to static life as a full-fledged staff officer. Even though he takes on the title of plans officer, he must still know the status of functions familiar to all XOs, such as maintenance, supply, fuel, personnel, ammunition, and equipment. Therefore, the company's first sergeant must carry the ball on tracking logistic functions, while the motor sergeant handles the maintenance issues. And when the company commander is unavailable, the XO acts on his behalf. In short, he runs the command and control node, which handles all the administrative and operational aspects of the company. This allows the commander to devote his energy to fighting the battle in the field, not in the TOC.

The XO must integrate with the task force staff from the moment the company TOC links with the maneuver TOC. When he receives an order from higher headquarters, he begins the engineer planning process with the task force S2 section as it conducts the intelligence preparation of the battlefield (IPB). The engineers receive and write the corresponding engineer battlefield assessment (EBA). It will be used as a planning tool by the engineer elements that receive output from the company TOC. The plans officer continues to mirror the maneuver planning process by analyzing the mission, developing the scheme of engineer operations, recommending a course of action to the engineer commander, and finalizing the engineer plan. Throughout the entire process, the engineer staff must be fully integrated with the task force staff to synchronize all aspects of the plan.

Engineer Plan. The meat of the engineer scheme of maneuver—the essential tasks derived from the higher unit maneuver operation order (OPORD)—must be in the task force OPORD. The plans officer must fight to prominently position engineer tasks in Paragraph 3 (execution) of the maneuver OPORD where all maneuver personnel will see them. Too often the engineer plan becomes an engineer annex to the maneuver OPORD. The engineer XO and the staff do too much detailed analysis of the terrain and enemy and friendly capabilities to bury the plan in an annex to the OPORD. Many tankers, infantrymen, and cavalrymen do not read the engineer annex.

Engineer Integration. During my first NTC rotation as XO, the company supported an armored cavalry squadron. I watched the S2 and his battlefield intelligence collection coordinator conduct the IPB during summer training. Initially, I tried to actively participate in their analysis; however, as they were always pressed for time to produce the modified combined obstacles overlay, I soon realized I was being left out. I observed their intelligence efforts and independently worked my own EBA. The staff briefings of mission analysis and courses of action to the task force commander also excluded the engineer—to the point where the company commander and I were present only as sounding boards. We had no input to briefings unless the task force commander asked for advice or we spoke out about a certain point. The OCs at the NTC thought this situation was unsatisfactory: As the plans officer, I needed to force myself into the planning process and integrate with all participants.

Before returning to the drawing board to determine how to integrate into the task force staff, I took some glancing blows on the subject of the company OPORD, which is closely related to the engineer annex. The commander and I debated how and when to get the company OPORD produced and briefed to the platoon leaders. We decided to put all the information needed by the task force in their base OPORD and use the engineer annex as the company OPORD. By making a few adjustments to the flexible doctrine covering the structure of the engineer annex, we ended up with a combination of an engineer company OPORD and an engineer annex to the squadron OPORD. The work of the plans officer was to write the engineer annex, the engineer company OPORD, and insert what he could into the main text of the task force OPORD.

There is no substitute for experience. In the second rotation, the commander was in the field commanding and the plans officer was in the TOC managing the time, resources, and personnel over the radio and through orders processes. As both the administrator of the company OPORD and the staff engineer, I sought guidance from the commander and interacted with the fire support officer, the chemical officer, the S2, the S3, and the task force XO and commander. With the commander's approval, I issued warning orders to the platoon leaders, giving them early notice to prepare for missions before joining the supported troops or entering their assigned engagement areas, and briefed the OPORDs. I had become the engineer company plans officer.

Remaining in the TOC began to make sense, although it took time to get used to taking care of the logistics and maintenance with minimal face-to-face contact with the first sergeant, motor sergeant, and those who executed the plans. I succeeded once I made that mental connection and learned to manage resources without physically seeing or touching them. I derived great satisfaction from making the plans, issuing the instructions, and then watching the plans become reality. Outstanding assistance from the company TOC crew ensured that I had all the tools to make the planning process work. Without a cohesive unit collecting necessary information and sending out required reports, even the best planner will fail.

TOC Crew

The TOC crew's role is more straightforward than the XO's. It helps when a senior sergeant first class with successful platoon sergeant experience fills the position of operations NCO. He understands how platoons operate in the field (what they need to know and when they need to know it) and how to issue and receive guidance, develop and execute plans, and track units in the field. His performance provides the foundation—that intangible asset of spirited crew teamwork both within the company TOC and the maneuver task force TOC—on which the company plan is built. The operations NCO's duties include:

- Obtaining company statuses for the plans officer.
- Informing the higher maneuver force TOC of company statuses.
- Forwarding information to the maneuver task force, both directly and through task force TOC channels.
- Updating the higher engineer command of operations at the company level.
- Managing the hands-on aspects of TOC integration.

Changes to the physical location of the TOC are a constant battle for workers who erect extensions, put up nets, run wire, man guard posts, regulate traffic and parking, and copy overlays and orders. The operations NCO provides leadership within the company TOC. He deals with the task force operations sergeant major while the soldiers focus on gathering information for the XO.

"Engineers are always squared away!" This compliment was a double-edged sword for our TOC. Our operations NCO (a staff sergeant), the NBC NCO (a sergeant), and the M577 Command Track operator took pride in getting the operating environment organized and in working order before anyone else in the task force TOC. I applauded this accomplishment and shared their pride. We were ready to work, even though the entire team did not always share our attitude. The leadership challenge was to get out and do whatever it took to set up the entire TOC complex. The task force appreciated our efforts and treated us as a part of the team. The operations NCO's leadership provided that critical edge to keep the crew focused on doing the necessary tasks whether they wanted to or not. This focus helped because I knew that they were receiving and sending information as necessary, and I could concentrate on developing plans and orders.

The operations NCO also maintains shift manning schedules and sleep plans and ensures that information is exchanged from one shift to the next. Every aspect is crucial to the success of the company, the company TOC, and the entire operation, but it is a tough area to master and implement effectively. Given those tasks, the conditions are to plan and execute 24-hour field operations over 14 consecutive days with two NCOs, one vehicle operator, and the XO.

The task force TOC at the National Training Center.

The standard is to provide adequate support to the company and maneuver forces for the entire two-week period. There should be two people available at all times to monitor the radios and provide status updates to all concerned locations.

The XO, as the primary engineer staff representative, makes plans throughout the night so the OPORD will be ready at dawn. Therefore, it is impossible for him to run the TOC during the planning process. Most problems and questions from the company typically arise when the planning is taking place, because the unit is either moving or making initial preparations for the upcoming mission. These are critical moments; situations can quickly deteriorate, and reputations are on the line. This is when the commander is likely to get on the radio and demand answers.

As the engineer TOC second in command, the operations NCO uses his experience, engineer knowledge, and resources to run the TOC during the day. He must—

- Understand the mission.
- Know the location of the subunits and which elements are moving.
- Know the status of logistics, maintenance, and personnel.
- Provide instant answers to the plans officer, the higher engineer command, and the maneuver force.

For safety reasons, the M577 driver works the day shift to maximize the quality of his rest. Since the backup NCO also works during the day, the unit NBC NCO takes the night shift. This duty staffing works well except when daytime heat makes sleep difficult or when the TOC moves. Because moves occur both during the day and at night, everyone has a rough time with their sleep plan. The problem can be alleviated by providing shift change information checklists and recording information in the log, on the status board, and on the engineer map board. This process of transitioning the outgoing and incoming shifts minimizes problems caused by sleep deprivation—one problem being the failure to sufficiently inform the new shift.

Working Together

The fruit of the combined labors of the plans officer and the TOC crew is the smooth execution of the plan. The TOC must track progress, report to the maneuver force, and forward reports to higher commands. It is important to track changes to the plan from higher headquarters as well as facts from the field that affect the plan. Everyone needs continuous feedback and updates, and the most overlooked place to post the updates is within the maneuver TOC.

When the OPORD is complete, troop-leading procedures shift into high gear. Commanders arrive to receive their orders from the task force commander, and the staff looks forward to the next major event—the task force rehearsal. However, before the rehearsal can begin, troops must prepare the site. Either the engineer plan must be clear enough for the maneuver S2 and S3 representatives to construct the rehearsal site, or an engineer representative must talk them through the OPORD. Shift changes and information flow are crucial at this point, with respect to the sleep plan, because the plans officer probably is asleep.

The length of the shifts alone make them difficult, but another thing that makes them hard is the failure to adequately pass along pertinent information. My goal was to ensure that the TOC never had to say, "We don't know. The last guy didn't say anything about that." We only had that problem once, as far as major items were concerned, and that was when I failed to pass a copy of the time line to the operations NCO when

The plans officer (XO) briefs the scheme of engineer operations overlooking Red Lake Pass.

he came on the day shift. I inadvertently gave the only copy to the commander and left my TOC in the dark. As a result, the operations NCO failed to request approval for the FASCAM plan because he didn't know I wanted him to do that at 1000 hours. After that, shift change checklists and TOC copies of time lines and orders became a priority, and we made sure that all information passed from person to person.

Often the pace of the operation causes many changes or updates in the company, and while all affected personnel are notified, the staff may be unaware of the status. The plans officer must provide that service within the task force TOC as part of a battle drill in the company TOC. Crew members must know that information goes from the radio into the record log, then circulates among the staff cells, and finally ends up on an updated map board. Unfortunately, passing buck slips is just passing the buck. Problems can still occur when engineers emplace an obstacle, even though the OPORD shows where it is, the TOC reflects the status, and the overmatching unit is aware of the obstacle.

A point of contention was the extent to which the TOC should update other primary staff sections. The issue required the commander's guidance when each unit developed its SOP. We were dismayed when the FASCAM minefield destroyed two friendly scouts as they collapsed the screen line. We had approval from the brigade when we installed the minefield the night before. The task force staff was aware of the minefield, and the overwatching company commander knew its exact limits. Still, two vehicle commanders were uninformed or otherwise unaware that they had to consider their return route from the front lines. At the NTC, they only died for 24 hours, but in real life the commander would be writing letters of condolence to their families.

Communication inside and outside the TOC is always crucial but never more so than when updating the world on operational activities and statuses. Information on critical obstacle locations must be passed up and across engineer and maneuver channels.

The Challenge

I was fortunate to have two opportunities to excel at the NTC in the position of company XO. The second time, I took an additional step and served as the plans officer. The job was not much different from what I had learned in the Engineer Officer Basic Course as a task force engineer. At that time, I thought it was tougher because the task force engineer was also the platoon leader. Even now, the plans officer is not fully the task force engineer, as that title is bestowed on the company commander.

Through my experiences at NTC, I learned to be a disciplined plans officer, to integrate within the maneuver staff, and to accept the challenge to my sanity that was part of TOC operations. Although the TOC was in working order for that NTC rotation, I cannot help but look forward to the day when I become a commander. I will command from the field while my XO stays in the TOC, formulating the plans and calling me for guidance. Since I can't go back in time to be a line platoon leader, I must look ahead to the days when I can command from the front. I'll be looking for a good XO.

Captain Sands is assigned to the 2d Engineer Brigade, Republic of Korea. He serves as the XO for the 43rd Combat Engineer Company, 3rd Armored Calvary Regiment, during two NTC rotations. He was a platoon leader for another rotation and during Operation Desert Shield/Storm. Captain Sands is a graduate of the Engineer Officer Advanced Course and holds a bachelor's degree from the U.S. Military Academy.

Engineer Solution

Immediate Action Procedures for Chemical or Petroleum Spills

An individual discovering a petroleum or hazardous substance spill will take the actions listed below. The sequence in which the actions are performed depend on the circumstances and installation-specific guidance. Caution must be exercised—the primary concern for all actions is to protect personnel from effects of the spill. Protection of the environment is secondary.

Warning:
Approach spills from upwind where possible. Avoid physical contact with spilled chemicals or petroleum products.

1. **Protect yourself and others from harm.**

- Evacuate the premises if necessary.
- Use appropriate protective clothing.
- Extinguish smoking materials away from the spill.
- Remove other sources of potential ignition.

2. **Stop the flow if possible (only if it can be done safely).**

- Close the valve.
- Turn a ruptured or punctured container so that the point of exit is up.
- Place the leaking container in another container (over-pack drum).

3. **Notify the fire department and the organization's chain of command.**

- Call the fire department, which has trained personnel who can be immediately dispatched to the scene.
- If the telephone number is busy or there is no response, call 911 or your installation's equivalent.
- Report all spills, regardless of quantity, through the chain of command to the installation's point of contact (POC).

4. **Confine the spill if possible (only if it can be done safely).**

- Protect the floor or storm drains (cover them with mats; surround the spill with absorbent material).
- Shovel sand, sawdust or sweeping compound on the spilled material or place sandbags in the path of the flow.
- Place sweeping compound, absorbent pillows, pads or mats to confine the spill.
- Continue confinement efforts until the initial response team, normally the fire department, arrives.

List these procedures in the unit's standing operating procedure (SOP) and spill contingency plan. Check with your installation's environmental office and chain of command for specific guidance.

This Problem/Solution was provided by Major David Neeley, Chief of Leadership and Environmental Division, Directorate of Training and Doctrine, U.S. Army Engineer School.

LESSONS LEARNED:

Joint Engineer Operations

By Vern Lowery

"....The Joint Task Force J4 engineer cell stood up on 24 July 1994 at Stuttgart [Germany] and rapidly expanded to a staff of 7 officers (U.S. Army, Navy, and Air Force), 11 NCOs and 1 enlisted clerk. Deliberate planning (development of the civil engineering support plan, LOGCAP planning, map reconnaissance, and preparation of map overlay products) began immediately..."

From the Operation Support Hope-Rwanda After Action Report.

Since Operation Urgent Fury in Grenada in 1983, Army engineers have supported more than 100 joint deployments for training, war, and operations other than war (OOTW). All of these deployments involved joint service engineer forces. The following information describes a common thread of lessons learned from these operations to help ensure successful engineer missions. Army engineer units are urged to apply these lessons as they train to deploy for their next joint mission—wherever it may be.

Issue: Joint engineer capability.

Discussion: U.S. Army engineer units, commanders, and staffs operate jointly with Air Force, Navy, and Marine Corps engineer forces during force-projection operations. Each service brings specific engineer capabilities to support operational missions. Air Force Prime BEEF and RED HORSE squadrons are premier construction forces, as are Army combat heavy, Navy Seabee, and Marine engineer support battalions. Marine combat engineers perform missions similar to those performed by Army combat engineers but focus on supporting landing operations. All services have special engineer units that provide unique capabilities, such as Navy underwater-construction teams, Air Force pavement-repair teams, and Army prime-power teams. The U.S. Army Corps of Engineers (USACE) and the Naval Facilities Engineering Command (NAVFAC) both provide additional civilian engineer capabilities in areas such as construction contracting, real-estate acquisition, and construction management.

Recommendations: Joint force deployment planners develop a handbook that describes joint engineer capabilities. Use this handbook to tailor and package the minimum joint engineer force needed to meet future theater mission requirements.

Issue: Joint engineer assessment.

Discussion: Recent deployment experiences demonstrate the critical need for an early assessment of engineer mission requirements in the operational theater. Assessments determine the joint engineer force structure needed to perform missions, including the need for host nation and civilian-contracted engineers. Early assessments also identify engineer logistics requirements for demolitions, mines, force protection materials, and construction materials needed in theater.

Recommendations: Prior to deployment, the joint force engineer staff gather engineer-related information from all available sources including historical documents, maps, area handbooks, and reports from recently deployed joint engineer units. Talk with engineer units, agencies or civilian contractors already operating in the area. Ensure that the joint engineer staff is part of the advance party that deploys into the theater to confirm engineer requirements. Early assessment information must be immediately transmitted to joint force deployment planners and logisticians, who will use it to determine follow-on engineer force packaging and strategic lift requirements. Assess the following as a minimum:

- Threat engineer capabilities in likely lodgement areas for force protection, countermine, counter-obstacle, and early-entry force support requirements.

- The status of existing infrastructure in the area of operations including airfield, port, road, logistics base, and troop bed-down facilities; real-estate acquisition; construction material supply; construction management; and line-haul requirements.
- Existing topographic data and product availability and requirements for additional terrain visualization products.
- Special joint engineer requirements, such as prime power, fire fighting, water detection, and well drilling.
- Joint engineer command and control requirements, including headquarters staffing, communications and information systems.
- Engineer liaison requirements, including linguists and civil affairs personnel.
- The availability of civilian contracting personnel to meet mission requirements.

Issue: Topographic products.

Discussion: Only 5 percent of the Earth's land surface is covered with up-to-date, detailed topographic map and imagery products. Therefore, joint forces may not have the best terrain products available to plan and execute military operations when they deploy to contingency theaters. All deploying units require some type of map product before they launch forces from CONUS or other theaters. Satellite imagery usually is available for purchase and use until updated maps are received. Once in theater, all joint forces will require some type of topographic product.

Recommendations: The joint force engineer staff evaluate the availability of standard and nonstandard map products for the area of operation. Where shortfalls exist, the joint engineer staff should work closely with the joint force intelligence officer (J2) to define specific topographic product requirements. Through reconnaissance, surveys, and satellite imagery, they will coordinate the collection and creation of needed digital terrain data. Ensure that terrain-analysis and topographic-reproduction capabilities are available to the joint force throughout the deployment. Consider split-basing joint topographic capabilities from CONUS locations. Together with the joint force supply officer (J4), determine the need for establishing a joint topographic product storage and distribution capability in theater.

Issue: Joint level engineer special staff.

Discussion: The method used to control joint engineer forces is a key battle-command decision. During recent deployments, the joint engineer staff performed best when they operated as a separate, special staff section or when under the joint force J3. These alternative configurations allowed the joint engineer staff to efficiently meet both operational and logistics requirements. When placed under the joint force J4, the joint engineer forces invariably supported logistics forces in theater at the expense of maneuver and other deployed units.

Recommendations: Form the joint engineer staff section as a separate, special staff to the joint force commander. When engineer mission requirements in theater are not extensive, form the joint engineer staff under the control of the J3.

Issue: Separate engineer command and control headquarters.

Discussion: Another key battle-command consideration is the method by which joint engineer forces are commanded. Experience has shown that engineer work is poorly planned and executed when engineers are commanded by nonengineer headquarters (logistics or administrative).

Recommendations: Identify a separate engineer headquarters to command engineer forces. The headquarters may be service-specific or a joint operation depending on the size and composition of the joint engineer force in theater.

Issue: Joint engineer end state.

Discussion: A clearly defined joint engineer end state was essential during recent deployments. It was usually described in terms of minimum construction standards. The engineer end state helped joint force commanders determine their operational end states in theater. It also helped define the minimal joint engineer force package needed in the area of operations. A clearly defined engineer end state also helped mitigate indefinite engineer work, which is sometimes called "mission creep." When the joint engineer end state is achieved, engineer forces are able to perform other missions in theater or redeploy.

Recommendations: Based on the joint engineer assessment of theater requirements, the joint force engineer staff identify and recommend an engineer end state to the joint force commander. Avoid modifications to the end state after it is approved because changes may cause mission creep.

Issue: Infrastructure repair capability.

Discussion: Experience has shown that joint force missions usually are conducted in areas where the theater infrastructure has been destroyed during combat or man-made or natural disasters. Joint engineers are tasked to establish some type of bare-base infrastructure to support the deployed forces or to provide displaced civilians with minimal life support and a protected, healthy, and safe environment. Sanitary living and working areas usually do not exist. Water supplies usually are contaminated. Electric power grids normally are off-line. Airfields and ports are not operating at full capacity due to damage.

Recommendations: Joint engineer forces take all organic equipment when they deploy. Based on the early joint engineer assessment, be prepared to repair the infrastructure in the area of operations.

Issue: Force protection operations.

Discussion: Joint engineer forces have unique equipment and personnel capabilities that support force protection efforts. During recent deployments, they constructed protective facilities, bunkers, emplacements, vehicle barriers, fences, and other structures needed to protect the force.

Recommendations: Deploying joint engineer forces, with the joint force commander, establish the required level of protection and minimum construction standards for operating and life-support bases. Specify the need for security fencing, lighting, obstacles, and guard posts. To quickly identify and repair breaches, establish facility security inspection procedures with military and local law-enforcement personnel.

Issue: Countermine operations.

Discussion: Estimates indicate that more than 100 million uncleared land mines are spread throughout 62 countries. This equates to about one land mine for every 50 people on Earth. Cheap and easily obtained or constructed, land mines are the third world's weapon of choice. They directly threaten civilian populations and joint force operations. Recent deployment experiences clearly show that joint engineers must be proficient in countermine operations.

Recommendations: Work closely with the joint force J2 to determine the land-mine threat in the area of operation. Publish a mine-recognition handbook for deploying forces. Ensure that deploying forces are trained to identify, mark, and report encountered land mines. Ensure that joint force engineers are fully confident in the use and capabilities of the countermine equipment and that the equipment is fully operational. Conduct land-mine detection, marking, and removal training for joint force personnel assigned to countermine operations. Provide protective equipment and mine-resistant vehicles to joint force personnel who conduct countermine operations. Establish, disseminate, and enforce route-clearance, area-clearance, and marking procedures for the area of operation.

Issue: Joint engineer logistics.

Discussion: Joint engineer forces recently had to rely on each other for logistics support for construction materials and demolitions. They established joint engineer supply yards when theater logistics agencies were unable to provide needed materials early in the deployment cycle.

Recommendations: Ensure that adequate construction materials are procured and shipped in time to meet initial life-support and force-protection needs. Ensure that construction materials flow in with deploying forces. With the joint force J4, establish specific locations for construction material yards and demolition storage areas. Establish specific requisition and distribution procedures for construction materials and demolitions.

Issue: Construction Contracting

Discussion: Joint forces often use civilian contracts to meet life-support needs in the area of operation. These contracts are primarily administered by the Logistics Civil Augmentation Program (LOGCAP). LOGCAP contracts include construction contracting, and LOGCAP contractors usually can meet large-scale construction requirements 30 days after an operation begins. Smaller projects may be satisfied earlier. Because of this capability, joint service engineer construction normally is required only until the LOGCAP construction contractor completely arrives in theater.

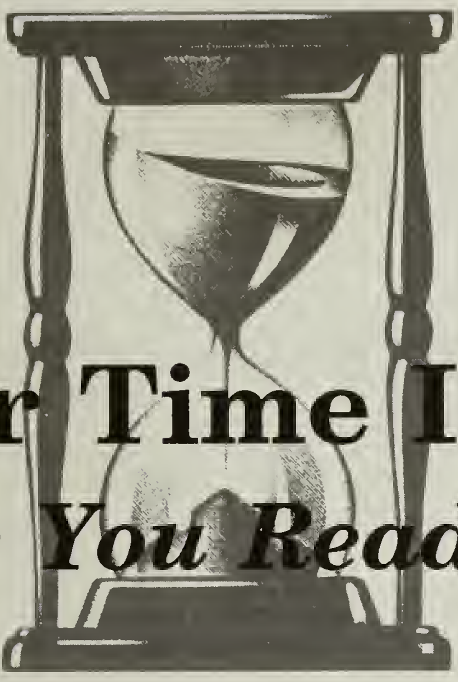
Recommendation: Ensure that the LOGCAP construction contracting capability is considered in joint engineer force deployment planning.

Vernon Lowery is the Deputy Battle Lab Support Element, Directorate of Combat Developments at the U.S. Army Engineer School, Fort Leonard Wood, Missouri.

Thank You!

The engineer Lessons Learned function at the U.S. Army Engineer School was transferred from the Directorate of Evaluation and Standardization (DOES) to the Directorate of Training and Doctrine (DOTD) when the school reorganized this spring. For lessons learned inquiries, contact Mr. Bill Blackwell at (314) 563-7744 or DSN 676-7744. Continue to send after-action reports from your training exercises and deployments to: Commandant, U.S. Army Engineer School, Attn: ATSE-TD-D-LL, Fort Leonard Wood, Missouri 65473. Lessons Learned information continues to be available on the Engineer Bulletin Board System and in the future will be on the Fort Leonard Wood Home Page of the Internet World Wide Web.

We at the Engineer School truly appreciate the cooperation provided by you, engineer units, and other agencies during the past several years in gathering lessons learned. The information you provided has significantly improved engineer doctrine, training, leader development, organizations, materiel, and soldier programs!



Itschner Time Is Near:

Are You Ready?

By Captain James Rosenberry

On my second day as a company commander at Fort Bragg, the battalion commander announced, "I expect each company to submit an Itschner book for this year's competition. I need it in two weeks..."

Memories flashed through my mind of previous commanders who had put these books together with little preparation and who seldom involved other officers in the book's development. So how was I, the new guy on the block, going to compile the information for the Itschner book, which reflects the company's previous year? I asked the outgoing commander if he had any photos or documentation to help me get started. Handing me a stack of files, he answered, "Here is some stuff; good luck." In talking with others, I learned that many new commanders find themselves in similar situations when they assume command in the fall. To help overcome the problem, I formed a team of NCOs and my XO to work on the project. The next step was to find the governing regulations and then learn just who Itschner was and what he stood for. After that, we were ready to plan a strategy to develop a quality submission.

When the book was completed—on time—I breathed a sigh of relief. But I vowed that next year we would be more prepared.

Well, it's that time of year again, when engineer companies across the Army are documenting their activities for the annual Itschner Award competition. Based on their submissions, the best engineer company from each Army component—Active, National Guard, and Reserve—is recognized at Fort Leonard Wood, Missouri, during the ENFORCE XXI (formerly SELTC) conference in April. The competition is tough, and the difference between winning and losing may be barely discernible. Commanders, executive officers, platoon leaders, and key soldiers work hard all year to gather material for their unit's presentation, each hoping to be recognized as "the best" from their category.

Regulations

USACE sends out a message in October with instructions regarding the award submission for that year. Currently, USACE message, subject: Society of Military Engineers Awards for 1994—the Itschner Award, dated 12 October 1994; and DA message, subject: Awards, dated 5 October 1992, provide guidelines. These messages, plus examples from your unit's previous submissions, provide a good start toward preparing an Itschner book.

The Award

The Itschner Award is named in honor of Lieutenant General Emerson C. Itschner, the 39th Chief of Engineers. During more than three decades of selfless service to our nation, Lieutenant General Itschner's name became synonymous with engineer excellence and leadership, both in peace and in war. The coveted silver plaques are presented to the engineer companies that best demonstrate and document the values associated with his name.

Planning Strategy

Early planning is the key to preparing a winning submission. Who should be involved? I'd suggest you include all of the officers and the first sergeant. Explain your intent and assign responsibilities and duties for gathering information throughout the year. Remember that too much information is better than not enough. You can always delete items, but you can never re-create a moment in time.

Unit photographs such as this one of the 536th Engineer Battalion, a previous Itschner Award winner, is a good way to show training situations and events pertaining to your mission.

A good photographer is essential to provide quality photos of all training and other events pertaining to the mission. What constitutes a quality photo? First, it must be in focus and have the correct exposure. Second, everyone in the photo must be in the proper uniform. Third, no safety or environmental violations should be recorded. The photographer should take a variety of shots: close-ups of people doing their jobs (get facial expressions); some medium shots, taken a few steps away from the project; and long shots, taken at a greater distance from the exercise.

Ensure that executive summaries, which capture the spirit and time of the event, are included with photos. Memories may be short-lived or become hazy with time, so don't wait until the end of the year to try to recapture the event on paper. Schedule progress reports quarterly, and update or change the collection plan for your submission as necessary.

Book Design

Compiling the data may seem overwhelming, but be patient with yourself and those who assist. The project may be easier to approach if you think of each part of the book as an individual project. Begin with a simple, professional-looking cover. Previous submissions have often incorporated engineer castles and colors and unit mottos, insignia, and memorabilia on the covers; however, the U.S. Army Corps of Engineers currently recommends using an Army issue, three-ring binder. Include a table of contents with properly tabbed markers to make the book organized and functional.

Ensure that there is material to cover all the subcategories required for the book. Many commanders compile outstanding books but fail to abide by the criteria. The following areas will be evaluated:

- Mission statement and mission-essential task list.
- Mission-related accomplishments, including training and combat support and construction tasks.
- Professional development programs, such as officer and NCO leadership, military occupational specialty/skill enhancement, and education.
- Recruiting and unit enlistment rates, to include first-term enlistments.
- Morale and welfare programs, such as improvements to troop living conditions; human relations, including drug and alcohol control; reportable government motor vehicle accident statistics, including total miles driven; reportable personal injuries; AWOL and courts martial rates.
- Community relations and domestic action programs.

Highlight combat training center exercises, deployments, disaster-relief operations, and other significant events. Successful books have a balance of photos and text that tell the company's story. Photos combined with computer graphics and brief descriptions have been very successful. Colored photos, paper, and print, with borders and maps, improve the book's overall appearance.

The company's contributions to the image of the Corps of Engineers are weighted heavily. For example, engineer units that deploy in support of operations in Somalia, Haiti, Bosnia, Macedonia, Central and South America, and the Pacific Rim significantly impact on the welfare of those people, their political structure, and social reform. They create a positive image of the Corps of Engineers both domestically and internationally.

The Itschner book is an excellent way to maintain a unit's history since copies can be archived in the battalion headquarters. This documentation is

Here, the 769th Engineer Battalion (top) and the 389th Engineer Battalion (bottom), both 1994 Itschner Award winners, effectively show their units in action.

especially helpful during the Army drawdown to record a unit's accomplishments.

Command Support

Unit commanders need command support when submitting their nomination for the Itschner Award. Not all units submit nominations every year, and sometimes those that are submitted are thrown together at the last moment to meet a requirement. This is not the intent of the Itschner Award program. A unit's attitude toward the submission is directly reflected in the overall presentation and content of the book.

Commanders should look at the positive effects of the Itschner Award program. Teaching junior officers about this program and its importance helps them prepare future submissions and promotes better team development within the unit. A certain level of pride and esprit de corps develops during the submission process.

If you aren't already documenting your unit's hard work and dedication, begin today so you won't have to rely on luck and files full of "stuff" when Itschner time arrives.

Captain Rosenberry is a small group instructor for the Engineer Officer Advanced Course. He previously commanded C Company, 37th Engineer Battalion (Combat) (Airborne) and served in Operation Desert Shield/Storm. He is a master rated parachutist. Captain Rosenberry holds a master's degree in management from Webster University and is a Command and General Staff College graduate.

Maintaining the Tank Mine-Clearing Plow

By Captain John T. Ryan, Captain P. Kevin Dixson, and Sergeant First Class James L. Richardson

The tank mine-clearing plow is a critical task force mobility asset. All too often, however, mechanical failures, insufficient crew training, or improper tactical employment make the plow seem like a mobility liability. Lack of crew training results in a mechanical failure or a maintenance problem. This, in turn, prevents the crew from training with the plow, which results in tactical employment problems.

FM 20-32, *Mine/Countermine Operations* states:

> *"The mine-clearing blade [plow] lifts and pushes mines, which are surface-laid or buried up to 12 inches, to the side of the track. The blade creates a 58-inch cleared path in front of each track. The skidshoe for each blade exerts enough pressure to activate most single-pulse mines and effectively clears a section of the centerline by mechanical detection. A dogbone and chain assembly between the blades defeats tilt-rod-fused mines."*

The following information will help engineer units prevent or solve some of the most common problems associated with the tank mine-clearing plow. We recommend that units follow these techniques and procedures when maintaining this equipment.

Three maintenance failures account for about two-thirds of all plow failures at the National Training Center: broken lifting straps, inoperable electric lifting motor, and sheared travel lock spindle and bracket.

Broken Lifting Straps

Problem. The nylon lifting straps that raise and lower the plow suffer much abuse. The straps frequently are cut or frayed by concertina wire or other sharp objects.

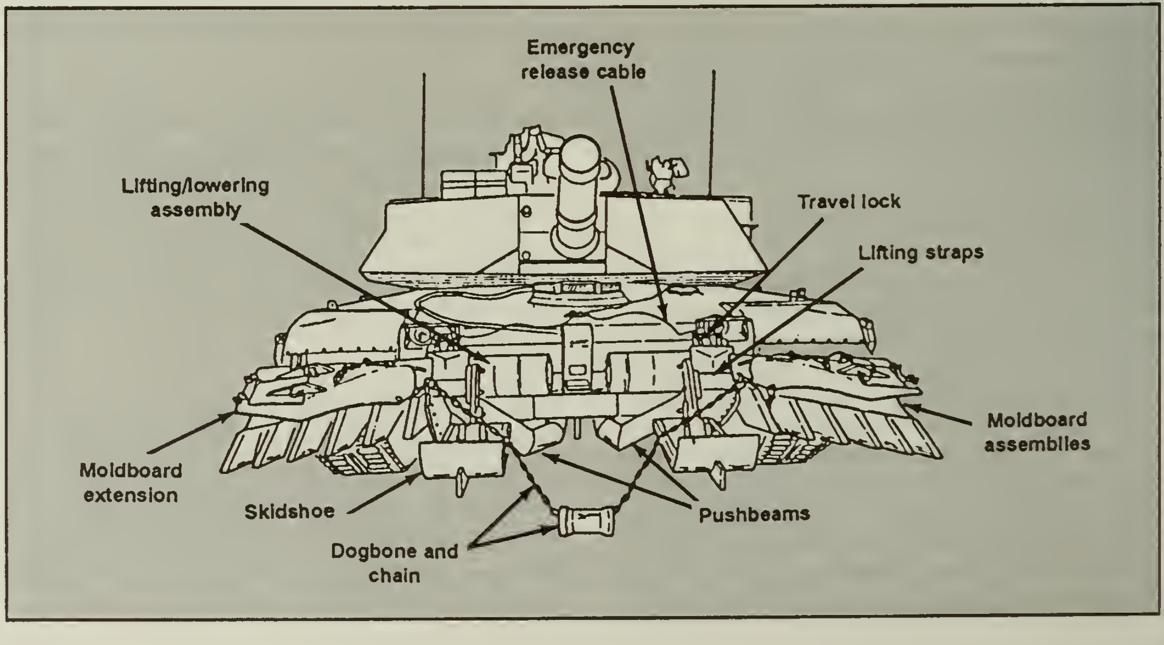
Solution. To prevent damage to the straps, some units bolt wire catchers, similar to those on the bumper of the old M-151 jeep, to the moldboard in front of the straps.

Problem. The straps also break when crew members attempt to lift a plow filled with too much spoil.

Solution. To prevent strap breakage due to overloading, stop the tank and back up about 3 feet when lifting the plow.

Inoperable Electric Lifting Motor

Problem. The most common problems with the motor are burned-out armature brushes and any of



several electrical relay malfunctions. The only authorized repair for burned-out brushes is for a DS-level mechanic to replace the entire motor. These motors are made in Germany, and orders often take several months to fill.

Solution. File the brushes from an old M-1 or M-2/3 starter down to the size of the armature brushes and place them in the lifting motor. This solution will reduce downtime for the plow from about three months to about three hours.

Problem. The electrical relays are not hard to acquire through normal supply channels, but most tank units do not keep a supply on hand.

Solution. Coordinate for electrical relays through an adjacent mechanized infantry battalion equipped with Bradley infantry fighting vehicles.

Sheared Travel Lock Spindle and Bracket

Problem. The travel lock spindle often shears when the plow drops or hits something while the vehicle is moving at high speeds. When the spindle shears off, downward motion of the plow causes the rest of the spindle to bend or break the bracket in which it is mounted. For some reason, the spindles on the left travel lock break more often than those on the right. In every case, the bracket breaks through the holes. When a plow breaks at the NTC, units seldom can replace the pushbeam during their rotation.

Solution. The only way to fix the bracket is to replace the entire pushbeam. Crews can avoid this time-consuming operation if they drive cautiously when the plow is raised.

Recommended PLL Stockage

NSN	Nomenclature	Quantity
4010-01-278-1216	Cable, Emergency Release	2
2510-01-276-7138	Pushbeam, L.H.	1
4010-01-277-5653	Preventive Chain Assembly	2
4020-01-289-8249	Strap, Lifting	6
5945-01-277-0085	Solenoid	2
5945-01-277-0087	Solenoid Limit Switch	2
5945-00-500-7195	Relay	1
5945-00-686-6877	Relay	1
6105-01-277-0295	Motor, 3 HP	1
5315-01-277-5641	Pin, Attaching	2
3040-01-K44-2243	Link	1
5315-01-277-5643	Spindle	4
3120-01-277-5652	Travel Lock Roller	4

Unit of issue for all items is 'each'.

Items in the chart are a recommended PLL stockage listing for a battalion equipped with 12 plows. This stockage is based on a 12-month NTC demand history.

Units equipped with this stockage or having access to it will be capable of making rapid repairs on the NTC battlefield.

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Captain Dixson is a small group instructor at the U.S. Army Infantry School, Fort Benning, Georgia.

Sergeant First Class Richardson (Retired) formerly served as an observer/controller at the National Training Center.

The ENGINEER Writer's Guide

We think engineers take a special pride in their profession, and *Engineer* is always looking for articles from readers who want to share their expertise, experience and ideas.

If you're a potential contributing writer, here are a few "writer's guide" tips to steer you in the right direction:

Articles may discuss engineer training, operations, doctrine, equipment, history, or other areas of general interest to an engineer readership.

We're especially interested in articles that have a "how-to-do-it-better" theme. For instance, we're not looking for articles telling readers how you conducted a routine field exercise. But if you think you have a "new-and-improved" way of conducting a tactical operation, training exercise, or other operational procedure that may prove helpful to other engineers—that's what we need.

Articles should generally come from contributors with first-hand experience with the subject being presented. Avoid theatrical writing styles like: "It was a dark and stormy night...," or "...the soldier blazed through the jungle on his lumbering D7, providing a trail of freedom for the other vehicles...."

Articles should be concise, straightforward, and in the active voice.

Length should range between 2,000 and 4,000 words, and the text should be typewritten and double-spaced. Generally, each such page will contain from 200 to 250 words.

Articles containing attributable information or quotations not referenced in the story should carry appropriate footnotes.

Manuscripts must be original, unpublished, and not under consideration by another publication.

All submissions are subject to editing.

Contributors are encouraged to include black-and-white photos, artwork, and/or line diagrams that illustrate information in the article.

Include your full name, rank, current unit and job title. Also include a list of your past assignments, experience and education; your mailing address; and commercial daytime phone number. Send articles to: Editor, *Engineer Professional Bulletin*, ATTN: ATSE-TD-D-EB, Fort Leonard Wood, Missouri 65473-6650.

If you have questions about an article you're working on—or considering writing—call Cathy Eubanks or Shirley Bridges, at DSN 676-4104, or commercial (314) 563-4104. We look forward to hearing from you.

Route-Clearance Operations

By Captain John K. Leighow

Current Army doctrine is too limited in its coverage of route-clearance operations. Since World War II, a steady increase in casualties from mine warfare suggests that our doctrine lacks the necessary scope and that we need training to successfully conduct combined arms route-clearance operations. Casualties from landmines increased from 4.4 percent in World War II to 33 percent in the Vietnam War. Twenty percent of the U.S. casualties during Desert Storm and 26 percent during Operation Restore Hope were caused by mines. While mine technology has surged, countermine capability is 30 to 50 years old.

Mine warfare is an important part of the opposing force (OPFOR) tactics, and much of it is concentrated along friendly lines of communication (LOC). For battlefield success, Army units must clear their LOC of any obstacles and enemy activity that disrupts circulation of forces and material.

Shortfalls in technology, doctrine, and training have all contributed to the limited success of route-clearance operations at the Joint Readiness Training Center (JRTC). Most units training here fail to recognize route clearance as a combined arms operation, and they routinely attempt to clear their LOC without conducting preliminary planning, task organizing, rehearsing, and battle-tracking procedures.

The "Thunder Run" is the most common route-clearance technique observed at the JRTC. Units roam the roads at 15 or more miles per hour looking for mines—and detect them when a vehicle explodes. U.S. forces cannot accept this approach. As a fighting force, we must develop ways to retain our mobility. This article identifies some of the problems in route-clearance operations and provides options to help ensure successful passage of the force.

Predictive Intelligence

By incorporating intelligence preparation of the battlefield (IPB) and mission, enemy, terrain, troops, and time available (METT-T) processes into route-clearance operations, units can predict what an enemy may do to disrupt their main supply routes (MSRs). The JRTC experience shows that units failing to conduct route-clearance procedures lose their flexibility and initiative during operations. Sun Tzu wrote, "Know your enemy, know yourself, your victory will never be endangered. Know the ground, know the weather, your victory will then be total." The IPB and the engineer battlefield assessment (EBA) provide ideal methods for establishing a minefield or ambush situation template. After the S2 and engineer identify the most probable threat sites, the S2 should designate them as named areas of interest (NAIs) for focusing reconnaissance efforts. Engineers trained to conduct enemy obstacle reconnaissance may work with scouts and infantry to confirm the presence or absence of ambushes and mines—the primary threats to battlefield circulation.

Ambushes. Small-arms fire is the number one killer on the JRTC battlefield. Several three- to five-man teams with small arms can effectively neutralize a brigade convoy operation through well-placed ambushes. They typically occur in areas of limited trafficability that provide the enemy with effective fields of fire, cover, and concealment.

Mines. These are the poor man's weapon of choice and the eternal sentry. Mines may be located almost anywhere and are devastatingly effective because soldiers do not understand their capabilities or observe their presence. Today's mines have blast-resistant fuses or use magnetic or seismic signatures to initiate the blast. This technology is far superior to the first-generation of pressure-fused mines still common in the U.S. inventory.

A favorite mine-warfare technique is to "reseed" a minefield along an MSR after a vehicle or a sweep team has cleared the road. The process, which takes about 30 minutes to complete, has a profound effect on the opposing force's mobility. As the force loses equipment and personnel to reseeded mines, the brigade and battalion task forces divert additional combat power to convoy escort. This may cause the brigade to lose the initiative. With these threats in mind, let's consider a more effective approach to route-clearance operations.

Minefield indicators (Figure 1) offer a visible signature that can help units confirm or deny minefield locations. They also serve as a starting point for finding the enemy and/or his cache sites. At the JRTC, the OPFOR can cache mines from 50 to 500 meters from any given minefield.

Minefield Indicators

- Damaged vehicles
- Dead animals
- Avoidance by the local population
- Signs of digging
- Signs of concrete removal
- Disturbances in a road, such as holes or grooves
- Boxes or parcels placed along the road/shoulder
- Parked vehicles or bicycles without operators
- Wire on the road surface or extending onto the shoulders
- Evidence of vegetation disturbance along shoulders
- Evidence of mine-peculiar supplies such as wrenches, shipping plugs, wrapping paper or safety collars from fuses
- Posted signs that covertly alert the local population to the presence of mines
- Observation of disturbances in tire tracks

Figure 1

Planning Considerations

Planning and conducting route clearance during the initial phase of combat operations ensures the survival of follow-on forces. According to FM 20-32, *Mine/Countermine Operations*, minefield clearance is conducted in a relatively safe environment and is "usually performed after the breaching operation by follow-on engineer forces or at any time in a friendly area of operations where an obstacle is a hazard or hinders movement."

Route-clearance operations are similar to breaching operations; therefore, commanders and staffs should plan and coordinate breaching fundamentals to suppress, obscure, secure, and reduce the obstacles. Task organizing for route clearance is also similar to that required for breaching operations. The assault force becomes the security element, the breach force becomes the sweep element, and the support force remains the same. FM 90-13-1, *Combined Arms Breaching Operations*, provides guidance for planning breaching operations and insights that apply to route-clearance operations.

The significant difference between breaching and clearing operations is that breaching usually occurs during an attack, under enemy fire, to "project combat power to the far side of an obstacle." Route clearance focuses on opening LOC "to ensure the safe passage of combat and support organizations" within an area of operation. Planning route-clearance operations, like breaching operations, requires extensive coordination and the use of all available assets.

Planning considerations for a combined arms route-clearance operation using the Battlefield Operating Systems include—

Intelligence

- Focus IPB to identify high-threat areas, such as chokepoints, bridges, culverts, tunnels, and intersections. Identify the key terrain and direct-observation and ambush sites. Identify probable mine locations as NAIs for reconnaissance focus.
- At the battalion level, maintain a mine-incident map and chart to facilitate pattern analysis. Compare mine incidents to the situation template and adjust accordingly.
- Coordinate overflight by unmanned aerial vehicles and attack/scout helicopter teams to provide daily intelligence updates. Film the route with aviation assets, if possible.
- Provide intelligence updates on mine-hazard areas to company and convoy team leaders.
- Establish liaison between the host nation, nongovernment organizations, and special operations forces for mine-awareness training and intelligence collection.

Maneuver

- Clear and secure the flanks (at least 100 meters in forested areas) and the far sides of suspected and known obstacles before marking and clearing them. Identify and clear potential sniper positions before clearing obstacles.
- Provide overwatching fire for the sweep team.
- Provide scout weapons teams for route overflights and security.
- Provide security for the cleared route.
- Provide aviation assets that are OPCON to the route-clearance commander.

Fire Support

- At the battalion level, position mortars to ensure continuous coverage of the operation.
- Prepare to cue the Q36 radar for counterbattery fire on enemy indirect-fire systems.
- Prepare to discharge nonlethal fires initially and then suppressive fires along the route on reported and suspected obstacle locations and sniper positions. Prepare fires within the tactical rules of engagement.
- Ensure that the route-clearance team has a fire-support coordinator.
- Ensure that priority targets shift in conjunction with movement on the MSR.
- Plan smoke on each target.
- Ensure that areas of control and responsibility are well understood.
- Establish a plan to clear fires.

Mobility/Survivability

- Conduct EBA in conjunction with IPB of routes.
- Provide clearing and sweep teams for the route according to FM 20-32, Chapter 10.
- Provide detailed obstacle intelligence on minefields. Include mine descriptions, obstacle composition, and enemy actions or techniques used during obstacle emplacement.
- Conduct a route reconnaissance to update map information.
- Conduct deliberate minesweeping operations after visually identifying an obstacle. Continue the mine sweep 200 meters beyond the known obstacle location.
- Ensure that all mines and obstacles are reported, marked, and cleared to facilitate unimpeded movement.
- Standardize all lane-marking materials and techniques.

Combat Service Support

- Designate one person to plan support for the route-clearance mission.
- Plan both air and ground casualty evacuation.
- Provide military police, preferably with explosive-sniffing dogs, to help with route clearance and security for convoys during and after clearing operations.
- Provide a medical team, with one or two ambulances, to accompany the route-clearance team.
- Plan for resupply during movement.
- Consider constructing static security points along the routes.
- Consider force-protection measures, such as wearing flak vests and hardening vehicles with sandbags.
- Plan for recovery assets during movement.
- Designate a movement-control element for follow-on forces.

Command and Control

- Plan centralized (brigade-level) or decentralized (battalion task-force-level) route-clearance operations according to METT-T.
- Designate an individual to be in charge of the entire operation and ensure that sufficient resources (communications, fire support, maneuver, and casualty evacuation) are available to accomplish the mission.
- Provide that individual with intelligence on his route and area of responsibility. Furnish the planning time, a proper task organization, and the extent of his area of operation or responsibility.
- Designate a controlling, coordinating, and supporting headquarters for route movement.
- Ensure that the tasked unit has a clear mission, intent, and end state. For example, will the unit clear only the road width; clear the entire route width including the shoulders; or clear, maintain, and secure the route?
- Determine routes with definable start and end points. Fix clearance responsibility between brigade- and battalion-level assets.
- Establish clearly identifiable checkpoints along routes to control traffic and monitor route-clearance progress.
- Coordinate with adjacent units as necessary. If the operation is conducted at the brigade level, coordinate additional support forces with the unit that owns the surrounding terrain.
- Track the progress and integrate it into the maneuver/combat service support plan.
- Ensure that ground commanders maintain communications with indirect-fire systems, scout weapons teams, higher headquarters, and adjacent units.
- Coordinate with host nation and nongovernment organizations.

- Designate a reserve that is at least platoon-sized and is either mechanized or air-assault capable.

Route-Clearance Methods

Units currently use the route-clearance method described in doctrine manuals—linear route clearance. With this method, sweep and security teams begin their route clearance at Point "A" and complete it at Point "B" (see Figure 2). At the JRTC, many route-clearance missions do not specify the location of start or end points, thus causing confusion between the planners and the executors. Linear route clearance is effective and popular, but it is not the most secure method to use in a nonpermissive environment. Two other route-clearance options are available: the combat clearance and the combat route-clearance methods.

Combat Clearance Method (Figure 2). FM 20-32, Chapter 13, describes combat clearance operations. While route-clearance operations focus on a specific route, combat clearance operations focus on an area or areas along a route. These are the suspected high-threat areas identified by the IPB and the EBA. The sweep force, composed of a mix of maneuver and engineer forces, secures and sweeps these NAIs. Combat forces then patrol the route to ensure that it remains secure and sweep the surrounding areas for caches if mines are present.

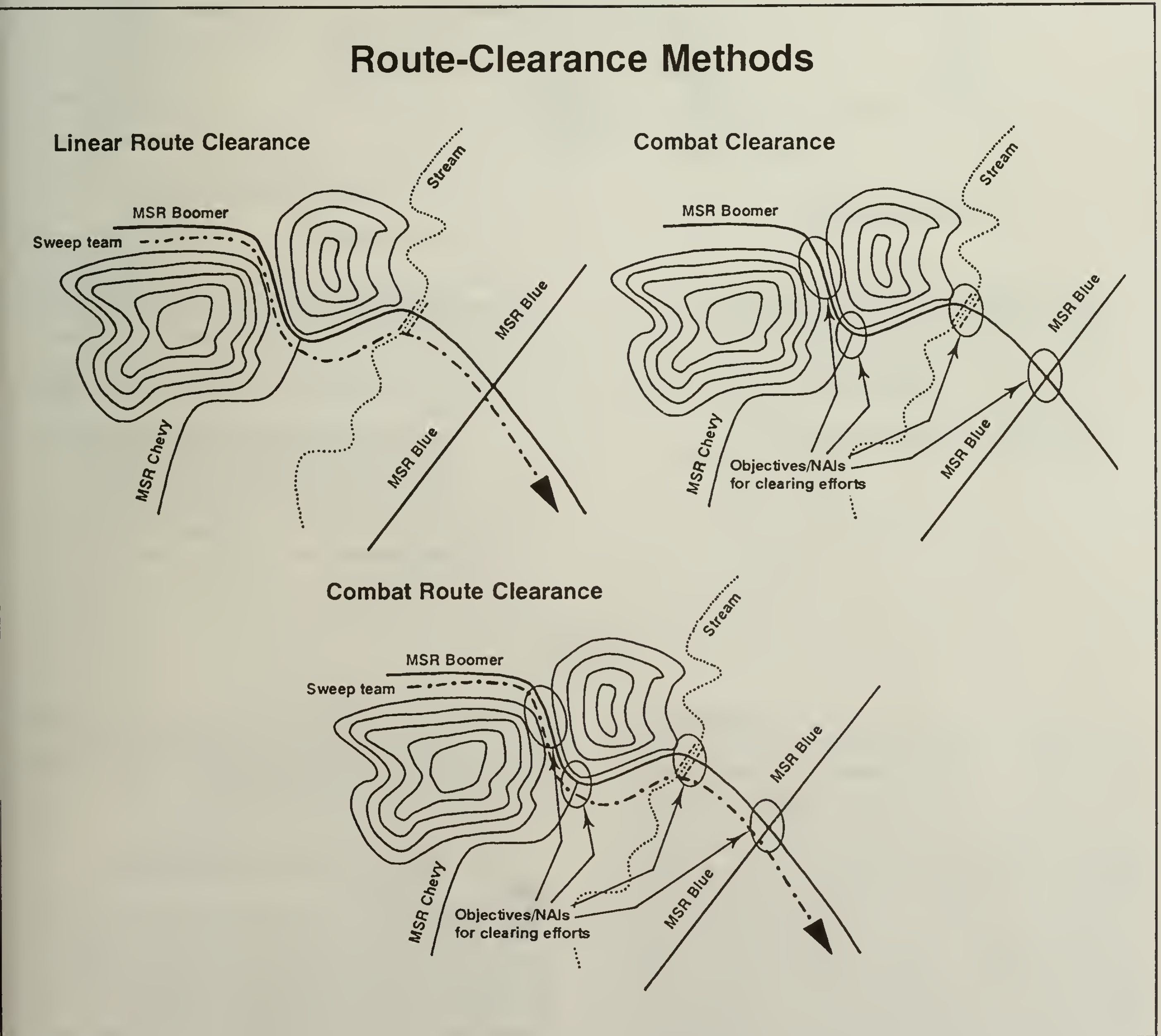
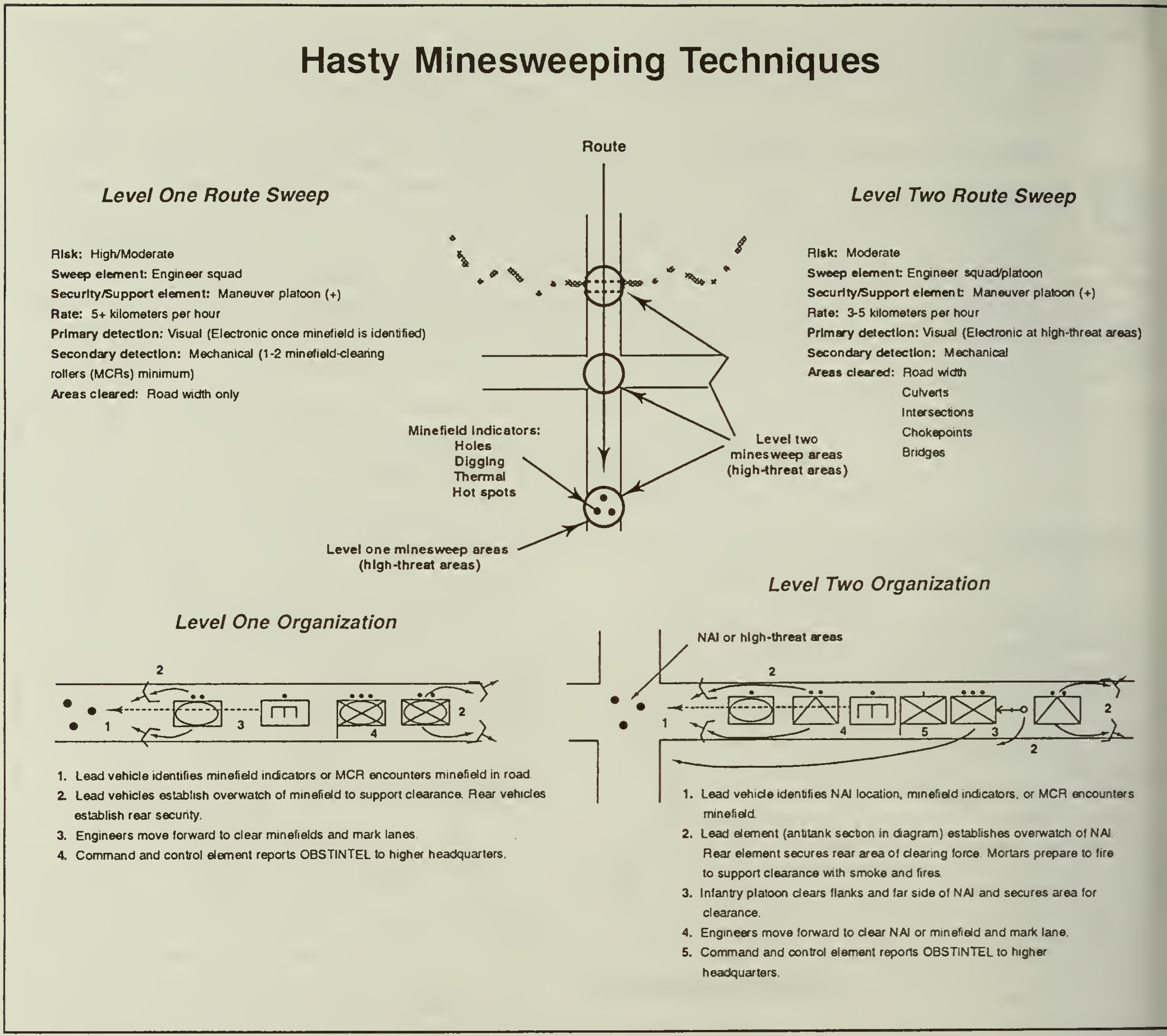


Figure 2



Hasty Minesweeping Techniques

Level One Route Sweep

Risk: High/Moderate
Sweep element: Engineer squad
Security/Support element: Maneuver platoon (+)
Rate: 5+ kilometers per hour
Primary detection: Visual (Electronic once minefield is identified)
Secondary detection: Mechanical (1-2 minefield-clearing rollers (MCRs) minimum)
Areas cleared: Road width only

Level Two Route Sweep

Risk: Moderate
Sweep element: Engineer squad/platoon
Security/Support element: Maneuver platoon (+)
Rate: 3-5 kilometers per hour
Primary detection: Visual (Electronic at high-threat areas)
Secondary detection: Mechanical
Areas cleared: Road width
Culverts
Intersections
Chokepoints
Bridges

Route
Minefield Indicators:
Holes
Digging
Thermal
Hot spots
Level two minesweep areas (high-threat areas)
Level one minesweep areas (high-threat areas)

Level One Organization

1. Lead vehicle identifies minefield indicators or MCR encounters minefield in road.
2. Lead vehicles establish overwatch of minefield to support clearance. Rear vehicles establish rear security.
3. Engineers move forward to clear minefields and mark lanes.
4. Command and control element reports OBSTINTEL to higher headquarters.

Level Two Organization

1. Lead vehicle identifies NAI location, minefield indicators, or MCR encounters minefield.
2. Lead element (antitank section in diagram) establishes overwatch of NAI. Rear element secures rear area of clearing force. Mortars prepare to fire to support clearance with smoke and fires.
3. Infantry platoon clears flanks and far side of NAI and secures area for clearance.
4. Engineers move forward to clear NAI or minefield and mark lane.
5. Command and control element reports OBSTINTEL to higher headquarters.

Figure 3

The combat clearance method is ideal for light forces because it allows maximum surprise and concealment. This method focuses the task force on opening and securing a route for follow-on forces and moving into the countryside to find the enemy.

Combat Route-Clearance Method (Figure 2). This method combines the complete route-clearance capabilities of the linear method with the security and surprise elements of the combat clearance method. It is a two-phased, force-intensive operation and may require a battalion-sized element, depending on the length of the route. First, identified high-threat areas are targeted, secured, and cleared of obstacles and enemy forces before a sweep team moves. The sweep team then travels down the road and clears obstacles missed or not identified during the IPB/EBA process. The advantage of this method is that the task force commander immediately secures his MSRs and then finds the enemy, confident that his MSRs are relatively safe.

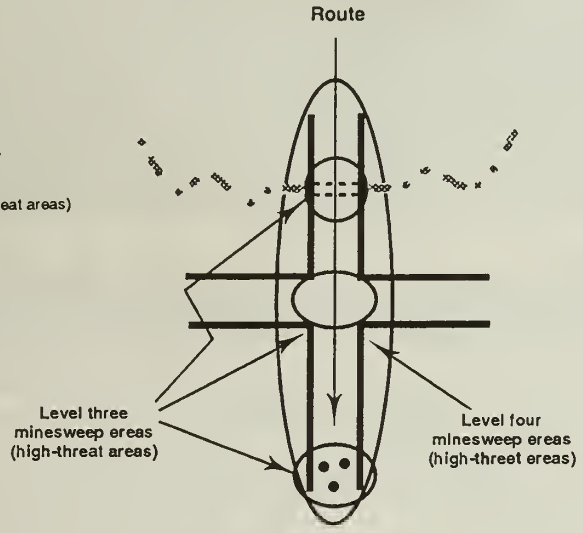
Route-Sweep Techniques

Current doctrine prescribes two minesweeping techniques: hasty and deliberate. These techniques should comprise the conceptual backbone of any mine-clearing operation. The hasty method relies on speed while the deliberate method relies on thoroughness. A hasty sweep over a 6-kilometer road takes from 1 to 2 hours (3 to 5 kilometers per hour); a deliberate sweep takes from 2 to 6 hours

Deliberate Minesweeping Techniques

Level Three Route Sweep

Risk: Low
Sweep element: Engineer platoon
Security/Support element: Maneuver company
Rate: 3-5 kilometers per hour
Primary detection: Visual (Electronic at high-threat areas)
Secondary detection: Mechanical (1-2 MCRs)
Areas cleared: Road width
Shoulders
Ditches
Culverts
Intersections
Chokepoints
Bridges
Optional: Route reconnaissance

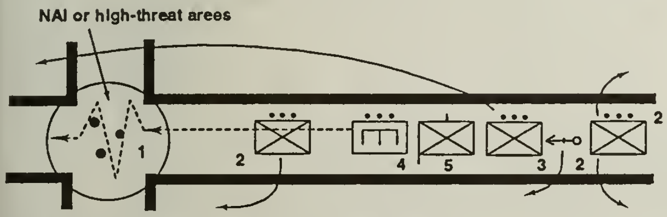


Route
Level three minesweep areas (high-threat areas)
Level four minesweep areas (high-threat areas)

Level Four Route Sweep

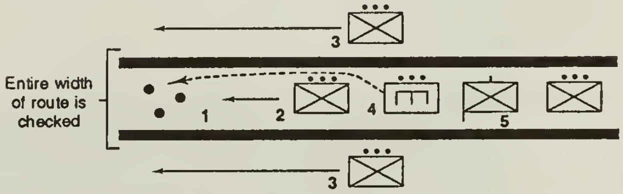
Risk: Low/None
Sweep element: Engineer platoon
Security/Support element: Maneuver company
Rate: 3-5 kilometers per hour
Primary detection: Electronic
Secondary detection: Visual
Tertiary detection: Mechanical (1-2 MCRs)
Areas cleared: Road width
Shoulders
Ditches
Culverts
Intersections
Chokepoints
Bridges
Optional: Route reconnaissance

Level Three Organization



1. Lead vehicle identifies NAI location or minefield indicators.
2. Lead element establishes overwatch of NAI. Rear element secures rear area of clearing force. Mortars prepare to fire to support clearance with smoke and fires.
3. Infantry platoon clears flanks and far side of NAI and secures area for clearance.
4. Engineers move forward to clear NAI or minefield and marks lane. Engineers conduct route reconnaissance of entire route.
5. Command and control element reports OBSTINTEL to higher headquarters.

Level Four Organization



1. Lead element identifies minefield indicator.
2. Lead element secures immediate area around minefield.
3. Flanking elements clear 100m off road for command detonated mines or off-route mines.
4. Engineers move forward to clear minefield and conduct a route reconnaissance of main supply route.
5. Command and control element reports OBSTINTEL to higher headquarters.

Figure 4

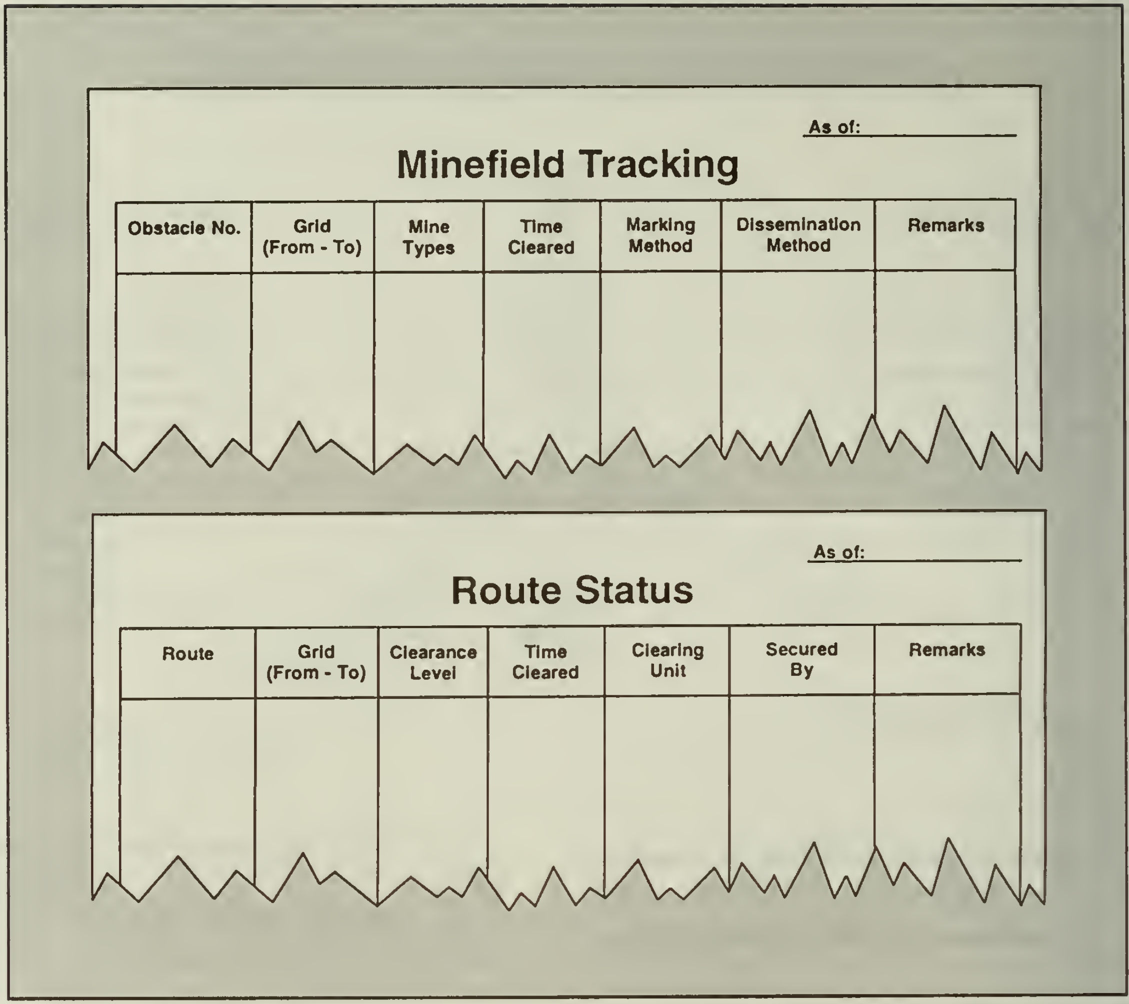
(1 to 3 kilometers per hour). Speed has a direct correlation with thoroughness in minesweeping.

Significant differences between these techniques are not described sufficiently in doctrine. Consequently, units experience problems in planning and xecuting route-clearance missions. Commanders and sweeping units should conduct route-sweep perations in four levels to reduce risks and ensure uccess. Levels one and two are modifications of a hasty mine sweep (Figure 3); levels three and four are modifications of a deliberate mine sweep (Figure 4). These techniques are used when conducting a linear route clearance or a combat route clearance. Sweep efforts are categorized by seven criteria:

- METT-T.
- Risk to traffic during and after clearance operations.
- Sweep rate.
- Task organization for the sweep.
- Security and support elements.
- Priority of detection method.
- Route areas checked.

These criteria provide enough information to communicate the route status after a sweep team has conducted its mission.

Level One (Figure 3). This is the fastest and most risky type of route sweep. It is ideal for an armored/mechanized team. The sweep relies primarily on visual detection, using thermal or infrared sights or the naked eye for mine identification. It is followed immediately by a secondary, mechanical detection system such as mine-clearing rollers (MCRs).



As of: ____________

Minefield Tracking

Obstacle No.	Grid (From - To)	Mine Types	Time Cleared	Marking Method	Dissemination Method	Remarks

As of: ____________

Route Status

Route	Grid (From - To)	Clearance Level	Time Cleared	Clearing Unit	Secured By	Remarks

Figure 5

The rollers are only effective on fairly flat surfaces and, when used against magnetic or seismic mines, the MCR's dogbone must be modified to avoid straddling mines. The sweep team is a squad-sized or larger element that is task organized with mine detectors, demolitions, and a vehicle-mounted mechanical detection device (see FM 20-32, Chapter 10). The sweep team looks for minefields on the road width of a route. Security and support teams consist of a maneuver platoon to provide overwatching fire (see Figure 3).

The primary objective of a level one sweep is speed, with the sweep team moving at 5 to 8 miles per hour. It is similar to the in-stride breach method when encountering minefields. The sweep team identifies immediate risks to traffic, neutralizes those risks, and continues on with the mission. If mine rollers are not available, a sandbagged 2 1/2-ton truck driven backwards can be used for a level one sweep (see FM 5-34, *Engineer Field Data*), but only as a last resort. In this situation, the mine rollers are only a means of detection, not breaching. Mine rakes or plows are not satisfactory substitutes because they destroy road surfaces.

Level Two (Figure 3). A level two sweep uses electronic measures as the primary detection method in high threat areas. These areas include intersections, chokepoints, and areas within 10 meters of woodlines. A level two sweep employs more caution and forces the unit to update the IPB before beginning the mission. This level of operation employs a company team for security and command and control (see Figure 3). Dismounted forces clear and secure the flanks and the far side of an identified minefield, while an engineer squad clears the road area.

Level Three (Figure 4). A level three sweep is more in-depth and more time consuming. The sweep team may be either mounted or dismounted, but it must examine the entire width of the route, including the shoulders and ditches. This technique ensures that follow-on forces are protected if they are forced to the side of the road. The security and support element also moves mounted or dismounted to provide rapid response and security (see Figure 4). The sweep team provides a route reconnaissance report that updates current maps and that further identifies high-threat areas. Staffs gain valuable information from this report for future operations.

"...well-trained units will always remain the foundation of U.S. Army route-clearance operations."

Level Four (Figure 4). A level four sweep is very ime-consuming. It relies on visual and electronic eans for clearance. The platoon-sized sweep team s dismounted to focus attention on the entire length f the route. The company-sized security element lears and secures the flanks and in front of the weep team (at least 100 meters in each direction in orested areas) (see Figure 4). This clears the area of ff-route and command-detonated mines and allows he team to focus solely on the route. MCRs are sed to proof the route after the sweep team passes hrough the area. Level four sweeps include route nd area reconnaissance. This sweep is used when horoughness and security, not speed, are critical to he mission.

Battle Tracking

Information and its dissemination are key to battlefield management. Failure to report and battle track minefields and route-clearance operations hroughout the area of operations are common shortalls at the JRTC. A successful technique used by one unit to track enemy minefields at the JRTC was o prominently post a minefield chart and overlay in he TOC that depicted both enemy and friendly ines and obstacles. Unit personnel posted known nd suspected enemy minefield locations, types of ines, marking method, time cleared, and remarks. As information was reported, the S2 changed the hart to reflect the time of the update, the receiver f the information, and the obstacle numbers (see igure 5). A similar, but separate, method should be sed to track route-clearance status (see Figure 5). Battle-tracked information should be maintained in oth the TOC and the combat trains command post nd then distributed to subordinate units, especially ombat service support units.The engineer should nalyze the information and provide the S2 and S3 with—

- Time the enemy requires to emplace mines.
- Specific enemy mine capabilities.
- Estimates of the time and assets required to clear enemy mines on the route.

The S2 should determine—

- When the enemy may reseed minefields.
- Possible locations of enemy mine caches.

The S3 disseminates this information to all units throughout the AO. The S3 should also determine—

- Air defense artillery requirements to cover enemy aerial resupply points.
- Surveillance requirements for targeting enemy minefields.
- Potential sites for ambushes around suspected enemy minefields.
- Ground force requirements to clear the area of enemy mines or to locate enemy mine caches.
- Movement-control requirements on routes and notification procedures when the area is cleared.

Experience at the JRTC shows that units consistently lose the initiative because they haven't conducted sufficient combined arms route-clearance training at their home station. When units conduct a route clearance, they go straight down the road, even when a sweep team is on-hand. The U.S. Army's ability to conduct countermine warfare and to open routes is handicapped by the lack of detailed doctrine and technology. Until countermine technology catches up, proficiency in execution must make up the difference. Even with improved technology, well-trained units will always remain the foundation of U.S. Army route-clearance operations.

Captain John K. Leighow served as an Assistant G3 Operations Officer in the 6th Infantry Division (LT) and as a Company Commander with the 6th Engineer Battalion in Alaska. He served as an Observer/Controller at the Joint Readiness Training Center at Fort Polk, LA. and is currently working as the engineer in the JRTC Plans/ Exercise Maneuver Control Center.

Engineer School Directory

Many telephone numbers for the U.S. Army Engineer School changed in June 1995. The following numbers allow callers to reach key offices. Commercial numbers are (314) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Commandant
MG Clair F. Gill
563-6116

Engineer Center Command Sergeant Major
CSM Roy L. Burns, Jr.
563-6149

Assistant Commandant
BG Phillip R. Anderson
563-6159

Chief of Staff
COL Anders B. Aadland
563-6118

Deputy Assistant Commandant
COL Hans A. Van Winkle
563-4093

Deputy Assistant, Army Reserve
COL Thomas Kaliher
563-4033

Deputy Assistant, Army National Guard
LTC Virgil L. Iiams
563-4034

Technical Director, Deputy Assistant Commandant
Lou Holtz
563-4093

Liaison Officers
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563-6132
British Army, COL Timothy Bradwell
563-4018
Canadian Army, MAJ Douglas Wright
563-4017
French Army, COL Jean Lafargue
563-4027
German Army, LTC Reinhold Hocke
563-4029

Directorate of Training and Doctrine (DOTD)
Director
COL Thomas J. Hodgini
563-4111

Sergeant Major
MSG David Delgado
563-4111

Engineer Hotline
563-4098

Engineer Professional Bulletin
Catherine Eubanks
563-4104

Directorate of Combat Developments (DCD)
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563-4076

Sergeant Major
SGM Reginald Hall
563-4076

Directorate of Tactics, Leadership, and Engineering (DTLE)
Director
LTC(P) Robert L. Davis
563-4119

Sergeant Major
SGM Allen Chatter
563-4119

Engineer Personnel Proponency Office (EPPO)
Chief
Victoria Anthony
563-4087

Warrant Officer Branch
CW5 Frederick Carson
563-4087

Engineer Branch Safety Office
James G. Runge
563-4025

Garrison Commander
COL David A. Fagan
563-4005

1st Engineer Brigade
COL Frank D. Ellis
596-0224, DSN 581-0224

CSM Edward Lugo
596-0395, DSN 581-0395

ENGINEER UPDATE

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Directorate of Training and Doctrine (DOTD)

New Director Welcomed. DOTD welcomed Colonel Thomas J. Hodgini, their new director, in June. He previously served as the Advanced Concepts Officer, Directorate of Combat Developments, U.S. Army Engineer School. COL Hodgini may be reached at -4111.

Field Manual (FM) 5-100-15 Distributed. FM 5-100-15, *Corps Engineer Operations*, was distributed in June. It addresses the role, organization, and command and control of corps engineers and the conduct of corps-level engineer operations. POC is Joe Sillyman, -4099.

Soldier Training Publications (STPs) Published. STPs 5-51T12-SM-TG and 5-51T34-SM-TG will have a print date of 17 August 1995. These STPs provide alignment for the consolidation of military occupational specialties (MOSs) 51G, 81B, and 82B. They include automated tasks for drafting and surveying. POC is SFC Tony Arnold, -4115.

Engineer Lessons Learned. The latest Engineer School reorganization has placed the Lessons Learned Branch under DOTD. Mr. William Blackwell is charged with continuing and improving the lessons learned function. We look forward to assisting you. Mail requests to: Commander, U.S. Army Engineer School, ATTN: ATSE-TD-D-LL, Fort Leonard Wood, MO 65473-6600. The E-Mail address is: BLACKWEW@WOOD-VINES.ARMY.MIL. POC is Bill Blackwell, -4099.

Directorate of Combat Developments (DCD)

Armored Vehicle Launched MICLIC (AVLM). An AVLM mounting device has been approved for use by field personnel. Procedures for its fabrication, installation, and use are contained in Change 1 to TM 9-1375-215-14&P, dated December 1992. All parts are common hardware items and manufactured components. Safety-of-Use message 94-05, which bans the use of all unauthorized MICLIC launchers, remains in effect. Change 1 was formally distributed on 30 June 1995. To obtain copies, call Michael Dawson at (309) 782-1521, DSN 793-1521. POC is SFC Andra Brown, -4074.

Ideas Requested. To pull ourselves into the 21st century, a process action team (PAT) is creating a vision of how Army engineers will operate in the far term (2020 and beyond). The team is collecting ideas applicable to developing that concept. To participate, send ideas to: Directorate of Combat Developments, ATTN: ATSE-CD-XXI, Fort Leonard Wood, MO 65473. The E-Mail address is FOWLERM@WOOD-VINES.ARMY.MIL. POC is Mike Fowler, -4082.

Digital Map Production Shortcut. The Terrain Visualization Center (TVC) seeks new methods of transforming topographic information from paper maps to digital geographic information system (GIS) products. TVC personnel recently discovered a method of digital map production that significantly reduces the plot time of the Hewlett Packard 650C printer. Using this method reduced the plot time for a 3-foot by 6-foot plot from about 30 minutes to less than 10 minutes. To use this method:

- Change the front panel to "long menu".
- Select SCSI "special" (follow the front panel manual).
- Select the "draft" mode on the panel, which allows the plotter to print bidirectionally.

That's it! Now you can plot quickly or in the enhanced mode, which takes longer but produces a higher quality product. POC is Marsha Mocaby, -4077.

Engineer Branch Safety Office (EBSO)

Sharing Safety Success Stories. While EBSO personnel continue to request information on safety-related deficiencies in fielded equipment or training, we also want to hear about success stories. Successes may be approved modifications to equipment or tactics or training that results in reduced risks to soldiers. To share your unit's successes, call Mark Totzke at -4074 or Paul Rusinko, -4025.

Reserve Components (RC)

Deputy Assistant Commandant-Army Reserve. Colonel Thomas L. Kaliher is the new Deputy Assistant Commandant-Army Reserve. He came to Fort Leonard Wood from the 412th Engineer Command, Forward, in Germany, where he served as Deputy Assistant Chief of Staff, Forward. COL Kaliher may be reached at -4034.

RC Combined Arms and Service Staff School (RC-CAS3). Reserve officers can complete RC-CAS3 at USARF schools. The course has three phases. Phase I, taken after the Engineer Officer Advanced Course, is a 141-hour correspondence course. Phase IIA, taken after completing Phase I, consists of eight weekend classes. Phase IIB is two weeks of resident training. Individual Ready Reserve (IRR) officers should submit a DA Form 1058 to their personnel management officer. Troop unit members enroll through their training officer via the Army Training Requirements and Resource System (ATRRS).

Libby NCO Academy

Bridge Demolitions. As of 1 October 1995, the Sheffield method of bridge demolition will no longer be taught in depth at the Advanced Noncommissioned Officer Course (ANCOC). While students will receive a brief review, they must arrive at ANCOC with the ability to check the calculations and bridge categorizations of subordinate leaders. Less than 3 percent of arriving ANCOC students understand the Sheffield demolition method. This presents a knowledge gap between sergeants leaving the Basic NCO Course (BNCOC) and their platoon sergeants. Senior NCOs must be trained on the Sheffield demolition method so they can effectively train and supervise subordinates. Unit commanders must utilize NCOs who have received this training in BNCOC and ANCOC to train their units. Bridge categorization and demolition are outlined in FM 5-250, Chapter 4, Appendices A and H. An article in the next issue of *Engineer* will discuss bridge demolition procedures and training support packets. POCs are SFC Glover or SFC Joos, (314) 596-0131, Ext. 3-7576/7782.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

> *"Change is the law of life and those that only look to the past or present are certain to miss the future."*
> John F. Kennedy

Certainly this a challenging time for noncommissioned officers (NCOs). Over the past three years we have seen dramatic changes in the world, our Army, and the Corps of Engineers. The NCO, as the backbone of the Army, must adapt to these changes and provide focus and leadership for our junior soldiers. Traditional NCO duties and responsibilities will not change. We will still lead, train, counsel, and evaluate. But now NCOs must place themselves in the forefront of change, not just be sentinels of tradition. Senior NCOs must eagerly seek to learn the new skills demanded by technically advanced systems and then begin training their teams to established standards.

Significant changes in our Army and at your Engineer Center are propelling our branch into the 21st century. As we say farewell to MG Ballard and welcome MG Gill as the Engineer School Commandant, I will take this opportunity to highlight some of these changes.

- Interservice Training and Review Organization (ITRO) initiatives are a real success story. Under the ITRO program, the Army, Navy, Marines, and Air Force share training assets, which significantly reduces redundancy between the services. The bottom line is that ITRO saves money and improves training efficiency. Fort Leonard Wood is the primary ITRO site for heavy engineer equipment training and motor transport operator training. We also train Navy, Air Force and Army electricians. While marines, airmen and sailors are training at Fort Leonard Wood, our engineer soldiers will train to be plumbers at Sheppard Air Force Base. Our firemen will train at Goodfellow Air Force Base, and carpenters will train at the Naval Technical Engineering Center at Gulfport, Mississippi.
- As we consolidate training assets, we are also consolidating skills. One such initiative is the multirole bridge company. We are evaluating the consolidation of fixed and float bridging assets into one company to create a more flexible and responsive combat support unit. After the consolidation is completed, bridge specialists (12C) will maintain their skills on many types of bridging by increasing their training frequency.
- We are also consolidating MOSs 12B (Combat Engineer) and 12F (Engineer Tracked Vehicle Crewman) to provide more versatile and skilled 12B soldiers for the Army. Consolidation of these two specialties lays the foundation for the transition to Force XXI. It provides advantages to soldiers: increased assignment and promotion opportunities and opportunities to broaden MOS-related skills. Benefits to units include enhanced assignment flexibility, a simplified replacement process, and greater diversity among senior NCOs. The Army benefits from reduced management costs. This is a win/win situation!
- Information management is now only a keystroke away. Technology, efficiency and the shrinking budget are driving the need to change. The Engineer School is now on-line. Some information from school directorates is available over Internet and more will be added. A challenge for engineer NCOs is to become competent in operating complex communications equipment both in the office and on the battlefield.
- New engineer equipment will greatly enhance our ability to fight as members of the combined arms team. Prototypes of the Grizzly have been handed to the Army for testing, and Wolverine prototypes are due shortly. This equipment promises to become the cornerstone of engineer support to the maneuver force as we shift to an M1/M2-based combined arms team. Modernization enhancements are being fielded in the areas of countermobility, survivability, sustainability, and topographic engineering to both light and heavy engineer forces.
- Finally, as a result of the recent Base Realignment and Closure (BRAC) recommendations, the Chemical and Military Police Schools are slated to move to Fort Leonard Wood. This initiative will considerably improve the future of engineer, chemical, and MP support to the Army. With those moves, the Engineer Center will become the Army's "Maneuver Support Center."

We look forward to working with MG Gill in meeting these challenges. Engineer NCOs will play the critical role in executing these changes and in adapting to a smaller, leaner, and more technically advanced Army. As our engineer motto states, ESSAYONS—let us try. We must resolve to change for the better and to meet the future fully prepared.

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December 1995

River Crossing

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AT URBANA-CHAMPAIGN

Headquarters, Department of the Army

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CLEAR THE WAY

By Major General Clair F. Gill
Commandant, U.S. Army Engineer School

In this era of dynamic change and development, I am proud to be the 50th Commandant of the U.S. Army Engineer School and the Commanding General of the U. S. Army Engineer Center. With your help, we are developing a single vision for our Engineer Regiment to move us successfully toward full implementation of Force XXI and the Army Maneuver Support Center, while we continue to sustain our reputation as a world-class training facility here at Fort Leonard Wood.

My boss, General Hartzog, has designated me as Engineer Personnel Proponent and Engineer Branch Chief. He has charged me to ensure that Army engineers maintain a key role in the combined arms team as we work to deter combat and promote peace in theaters around the globe.

One major task is to formulate a proponent strategic plan that will chart a pathway to our future. We all have strategies, plans, and immediate missions that demand daily attention and resources. But we also need a long-term focus (strategic plan) to integrate into broad operational requirements and planning. Strategic planning is our corporate responsibility. My chartered team at Fort Leonard Wood recently formulated draft vision statements for both the Engineer Regiment and Fort Leonard Wood:

"The Engineer Regiment...trained and ready,
a rapidly deployable and versatile member of the
strategic force...combining efficiencies of information
with physical and technical capabilities,
to master terrain in support of decisive victory."

Fort Leonard Wood's vision reads:

"America's center for maneuver support to the total force...the world's best multifaceted training center...a people-focused leader in quality of life, residing in the Ozarks...an active civic partner...a foundation for exceptional service to our nation and its values."

When finalized, these statements will complement the TRADOC effort to develop a 21st century Army.

The teams are now translating these visions into long-term goals and their supporting near-term objectives. Together, the vision, the long-term goals, and the immediate objectives define my intent—our intent. This approach will constitute our deep battle and will be fully integrated into the close fight.

While planning for the future, the Engineer Center team must continue to provide our regiment with the highest quality service in the three core mission areas: training soldiers, combat developments, and writing doctrine. The next step is to incorporate our regiment's vision into the entire Army engineer community and take the first steps toward its attainment.

Another important hat I wear is that of Maneuver Support Center planner. As a result of a recent Base Realignment and Closure (BRAC) decision, we have the mission to plan and execute receipt of the Military Police and Chemical Schools at Fort Leonard Wood beginning after 1998. In partnership with the commandants of the Military Police and Chemical Schools, we will form a consolidated organization tentatively called the "Army Maneuver Support Center." In the opertional concept, each branch will retain its commandant. He will remain the proponent for his regiment and its systems and functions.

I solicit your input throughout the entire planning and consolidation process. Teamwork is essential. I encourage you to share experiences, lessons learned, and ideas with others in the engineer community. Keep those phone calls, cards and letters coming. Use the Engineer Bulletin Board and the Engineer Hotline to get answers to your technical requests. Recent upgrades to Fort Leonard Wood's fiber-optic system allow us to "talk" via the Engineer School's Internet Home Page. *Engineer* magazine also has a role in my strategy, and I will use this forum to discuss key issues affecting our corps.

Together we will work to ensure that our great regiment remains a key member of the combined arms team, ready to support our nation and successfully meet any challenge. Essayons!

Engineer

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UNITED STATES ARMY ENGINEER CENTER AND FORT LEONARD WOOD

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Front cover photo: Active assault float bridge units (the 74th Engineer Company and the 489th Engineer Battalion) support the 353rd Engineer Group (USAR) during a river-crossing exercise in July 1995.

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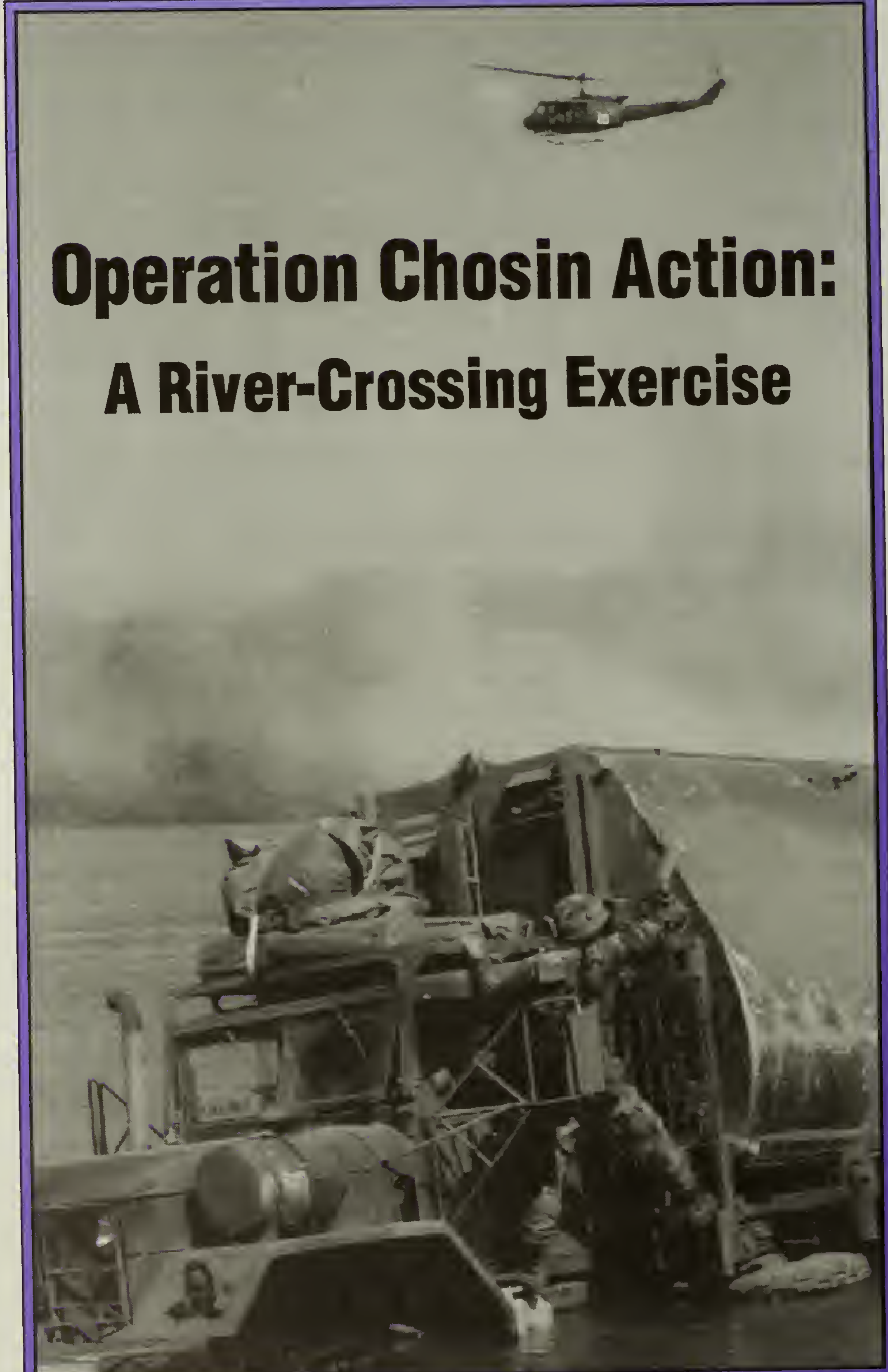
The following three perspectives of river crossings provide insight into this complex engineer mission. First, despite the odds, the 353rd Engineer Group (USAR) planned and successfully completed a bridging exercise across the Arkansas River. The second piece describes the rationale for the new multirole bridge company and the results of a recent concept evaluation for this program. It is followed by a review of river-crossing doctrine in peacetime conditions. We invite your comments concerning this topic.

Operation Chosin Action:

A River-Crossing Exercise



By Major James K. Rupp

Imagine evacuating a town of 5,000 people over a one-lane bridge, with every vehicle arriving at the bridge 100 meters apart—and with no traffic jams, no accidents, and no impatient drivers. This situation is difficult to envision, but it is what is expected when a division conducts a deliberate river crossing. A reinforced division crossing 20,000 strong at two brigade crossing sites with two bridges each equates to that town of 5,000 at each of the four bridges.

River crossing is one of the most complex engineer operations to plan and execute. In addition to overcoming the logistics problems, a deliberate river crossing must project forces across the river in synchronization with the commander's battle plan. Success depends on meticulous planning and numerous rehearsals.

Many in the engineer community misunderstand who is responsible for planning river-crossing operations. FM 90-13, *River Crossing Operations*, a combined arms manual, states that corps engineers are additional staff planners of crossing operations and provide command and control of the crossing assets. It also states that divisional engineers should focus on the fight. Yet, when the manual outlines planning procedures and responsibilities, it lists the brigade and the division engineers. ARTEP 5-145, *Mission Training Plan (MTP) for Engineer Brigades and Groups*, provides the tasks, conditions, and standards for an engineer group to plan a river-crossing operation. However, some group commanders maintain that it is not their mission but that of the division engineers. Division engineers say they have no bridging assets and therefore should not conduct the planning. We must clearly define this responsibility so that someone has ownership.

River-crossing exercises are not held often. During a recent 16-month period, four Warfighter exercises were conducted with Southeast and Southwest Asian and European scenarios and none of them included a river-crossing operation. Yet, if the United States was to fight in these theaters, it is unlikely that we could win without crossing a river. Additionally, III Corps at Fort Hood, Texas, conducted its Roadrunner exercise in September 1994 without a single river-crossing operation. In its after action review, III Corps stated that it had not conducted such an operation in 10 years.

Planning an Exercise

The 353rd Engineer Group (USAR), Oklahoma City, decided to conduct a river-crossing exercise because we have the MTP task to plan river-crossing operations. Although maneuver commanders are responsible for the operation, they depend heavily on the engineers' technical expertise. Operation Chosin Action, planned for mid-July 1995, would be a multiechelon exercise that integrated active and reserve units. To get the exercise

Engineer soldiers maneuver a bridge into position by hooking a boat to the bridge.

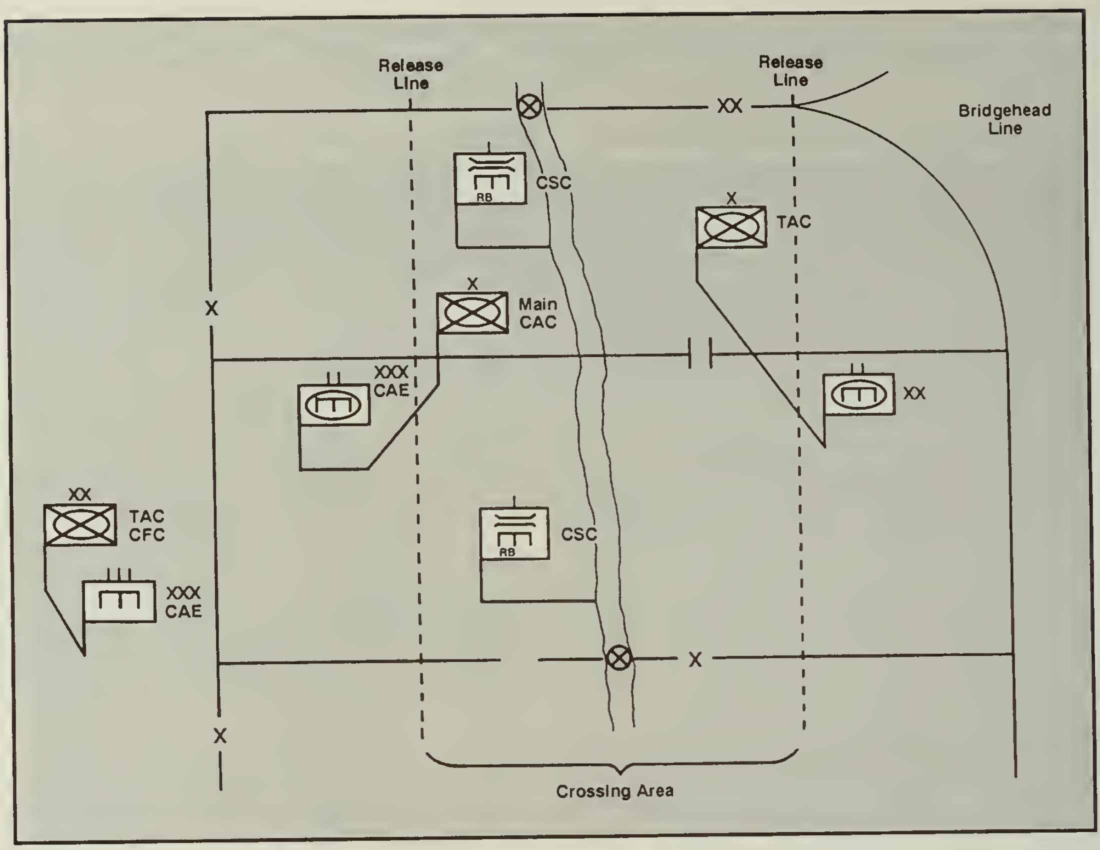


Figure 1. Control elements for a deliberate crossing

off the ground, the group identified a training area, a task organization, and a tactical scenario.

Training Area. Fort Chaffee, Arkansas, was chosen as a training area. The military reservation spans both sides of the Arkansas River, which allows control of both the entering and exit banks, and has four bridging sites. Permission to close the Arkansas River to navigation traffic during the exercise was coordinated with the Little Rock District of the Corps of Engineers and the U.S. Coast Guard.

Task Organization. Figure 1 shows the command and control relationships of a river-crossing operation. A full division crossing requires a minimum of two corps engineer battalions, four ribbon bridge companies, and numerous support units.

In the plan for this exercise, the commander of the 353rd served as the crossing force engineer (CFE) and the commander of the 489th Engineer Battalion (C)(M) (USAR), North Little Rock, Arkansas, served as the crossing area engineer (CAE). Other participants initially remained unidentified. One year before the event, the 353rd sent invitations to every Active, Reserve, and National Guard ribbon bridge company in CONUS and to military police, medical, aviation, infantry, and signal units. Although no one promised to be there, the group staff continued to plan the exercise. Ideally, a combat force would serve as crossing force commander (CFC). The next best alternative was for a maneuver training command to prepare and control the exercise. But those commands were preparing for lanes training and could not support our request. So the task of preparing the exercise scenario and controlling the exercise fell to the 353rd.

Tactical Scenario. Using operations orders, messages, and logs from two previous Warfighter exercises conducted by the 4th Infantry Division in Korea, the group staff pieced together a tactical scenario for Operation Chosin Action. By moving their operations farther south in the next Warfighter exercise, the 4th can use the same scenario for a deliberate crossing of the Han River.

While preparing for the exercise, the staff periodically contacted the units invited to participate. When none of them committed to attend, we thought that the multiechelon training exercise we were planning might become an elaborate command post exercise for just the group and battalion staffs. Then, in January, units began to confirm their attendance. As the task organization filled in, the possibility of developing a role for a diving detachment surfaced. Then vendors of Zodiac boats and Jet Propulsion outboards wanted the Army to try their new products. By April, all the pieces were in place. The final task organization is shown in Figure 2.

The battalion and group staffs conducted crossing area reconnaissance. They looked at routes and staging areas on the Arkansas River but could not get within 1.5 kilometers of the crossing site due to flooding. In May, this was a minor concern; but in June, when a reconnaissance with commanders

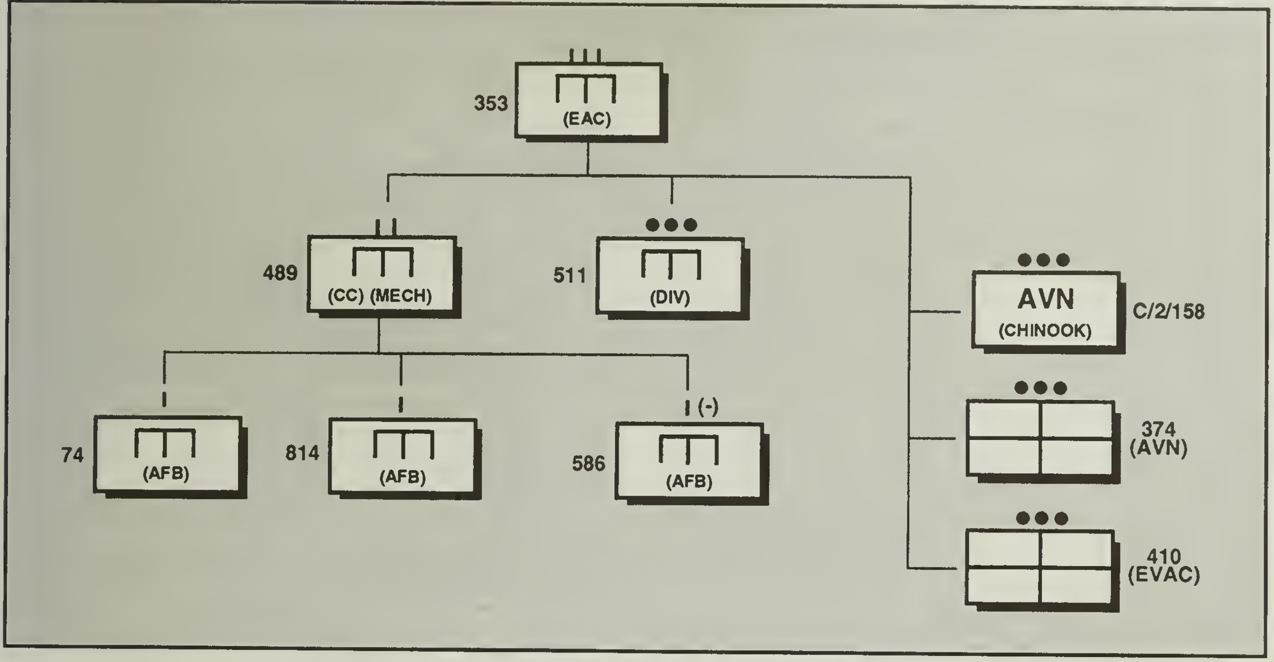


Figure 2. Task organization for Operation Chosin Action

from the bridge companies showed that the situation had not improved, it became a major problem. The hydrology division from the Little Rock District forecast that the river would recede before the crossing in mid-July. However, the weather and the snowmelt from the Rockies did not cooperate, and the river remained at flood stage. When the first units arrived on 8 July, the river was still 1 kilometer out of its banks.

Planning Process

Operation Chosin Action officially began at 1900 on 9 July when the division operations order was briefed to the engineer group and battalion commanders. The exercise included the following training objectives:

- The group staff will plan a division river crossing.
- The battalion staff will plan a brigade crossing and will command and control engineer units in the crossing area.
- The engineer companies will conduct river-crossing operations.

The flow chart in Figure 3 on page 6 guided the staff during their planning process.

Commander's Intent. Each step required close coordination between the crossing force engineer and the crossing area engineer. The plans developed for the brigade fit within the division commander's intent and were incorporated into the division plan. Before the crossing area engineer attempted the next step in the planning process, the crossing force engineer incorporated the brigade crossing plan into the division plan.

Restated Mission and Warning Order. A restated mission was developed and warning orders were issued to subordinate units. River-crossing plans were based on the 4th Infantry Division's task organization in the Warfighter exercises. The tactical scenario in these exercises called for two brigades crossing abreast to bypass and isolate Seoul. With only one crossing area engineer participating in Operation Chosin Action, the group staff planned the second brigade's crossing and incorporated it into the division river-crossing annex.

Crossing Estimates. The staffs prepared crossing estimates based on physical features of the crossing site and enemy countermobility capabilities. At regular intervals, they issued intelligence updates on enemy activities, engineering capabilities, and obstacles. Intelligence officers used Terrabase, a computerized terrain data system, to provide detailed terrain analyses and enemy obstacle templates. Korean terrain was used for the intelligence preparation of the battlefield, but the staffs used the physical terrain of Fort Chaffee at the immediate crossing sites. Site selection was based on the assumption that the river would recede, and the normal width of the river at the selected sites was used in the crossing estimates. The estimates were prepared on a spread sheet that broke the task organization down to company-sized elements. It showed the number of vehicles present, the number of raft loads required, and the

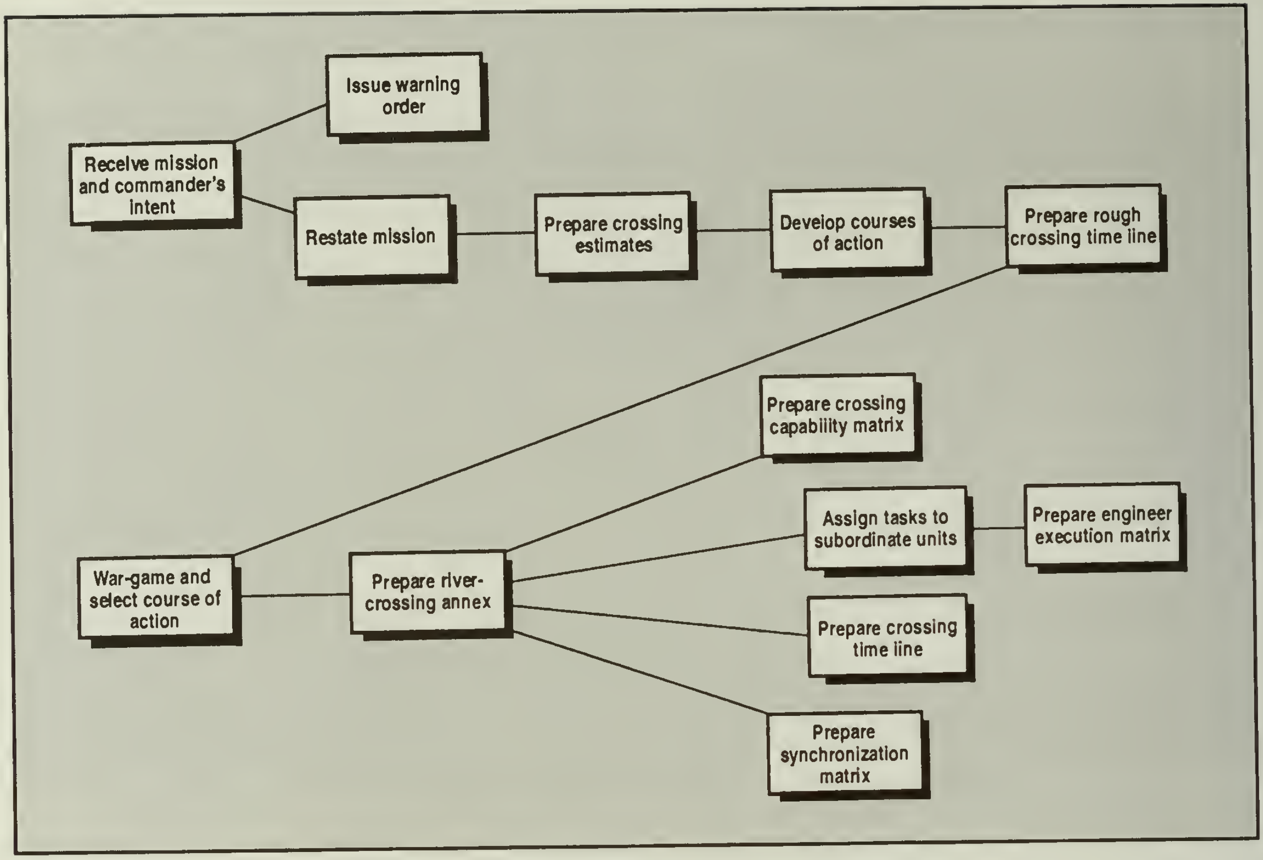

Issue warning order
Receive mission and commander's intent
Restate mission
Prepare crossing estimates
Develop courses of action
Prepare rough crossing time line
Prepare crossing capability matrix
Assign tasks to subordinate units
Prepare engineer execution matrix
War-game and select course of action
Prepare river-crossing annex
Prepare crossing time line
Prepare synchronization matrix

Figure 3. Planning process for a river crossing

time required to cross a bridge. The staffs calculated the time needed to construct rafts and bridges and the time required to make a round trip across the river. Using the spread sheet information, the staffs calculated rafting times and bridge-crossing times for each unit.

Courses of Action. Crossing estimates were the building blocks used to develop possible courses of action.

Rough Crossing Time Line. The staffs prepared a rough crossing time line for each course of action considered.

War Gaming/Course-of-Action Selection. After war gaming possible courses of action, the staffs made recommendations to the commanders, who selected the appropriate action.

River-Crossing Annex. The group staff prepared the crossing annex using input from the battalion staffs on crossing capability matrices and crossing time lines for the supported brigades. They incorporated the information into the division crossing capability matrix, crossing time line, and synchronization matrix.

While they planned the situational crossing, the staffs also planned an actual crossing with the units at Fort Chaffee. But with the river at flood stage, it looked doubtful that the crossing sites would be above water in time for the exercise. They asked the hydrology departments at both the Little Rock and the Tulsa Corps of Engineer Districts to determine how to reduce the water level and the best estimates of river flows and elevations. Both districts provided forecasts for the next six days. If the river elevations followed the forecast, the exercise could be conducted at the proposed site. If not, an alternate site owned by the Corps of Engineers would be used. Officers and members of the Fort Chaffee training staff helped coordinate for use of the alternate site and approved the route upgrades required to access it. The staffs prepared crossing annexes for a division crossing the Han River and for Fort Chaffee units crossing the Arkansas River at two locations.

Bridge companies from the 489th Engineer Battalion convoyed from Fort Hood, Texas; Fort Polk, Louisiana; and Fort Benning, Georgia. After conducting maintenance operations, they began rafting training at Engineer Lake and on the Arkansas River at the Corps of Engineer site. In addition to the river-crossing operation, the battalion conducted lanes training with support from its resident reserve training detachment.

Execution Matrix. On the morning of 15 July, subordinate units received the operations order to execute the crossing on Fort Chaffee and be prepared to use the alternate Corps of Engineer site. The width of the river at the alternate site (almost 500 meters) exceeded the bridging capability of two plus companies. Even with half of the active Army's bridging assets present, there was not enough to span the Arkansas River. The alternate plan was to conduct a rafting operation.

As the crossing area engineer prepared the engineer execution matrix, the engineer companies conducted reconnaissance and prepared for the exercise. The 74th Engineer Company practiced sling loads and conducted rehearsals with C\158th Aviation Company.

During this time, the 511th Engineer Diving Detachment from Fort Eustis, Virginia, was the focus of everyone's attention. Although there is no doctrine for using diving detachments in river-crossing operations, their ability to produce hydrographic surveys of the crossing centerlines, identify underwater near- and far-bank conditions, and breach underwater obstacles was critical in determining the crossing site. The data they collected, when correlated with data from the Little Rock District, showed that the Fort Chaffee site would be above water by 18 July and that bank conditions could support wheeled traffic.

Rehearsals

On the afternoon of 16 July, the units conducted a sand-table rehearsal of a crossing plan that had two center lines, one for rafts and one for the bridge. They exercised the traffic patterns on the sand table and resolved the identified problems—where to locate the engineer equipment park, the engineer routes, and the sling load area for the bridge bays airlifted to the site.

The crossing site was still partially underwater, the river width exceeded the available bridging capacity, and aviation support was unavailable for the full dress rehearsal on 17 July. Because the bridge company commanders were concerned about the river velocity and the bridge anchorage, they conducted a limited rehearsal with the following goals:

- Verify the traffic flow through the staging, holding, and call forward areas.
- Launch bays and construct rafts at the crossing site.
- Develop a bridge anchorage.
- Conduct rafting operations.

While the rehearsal was successful, several issues remained unresolved. Of the two centerlines identified, only one was usable and it was partially inaccessible. Divers conducted a hydrographic survey to define the site's underwater trafficable limits. The Little Rock District projected water elevation drops for the evening of 17 July and the morning of 18 July. Even so, the crossing sites would still be partially underwater, but with some work one site would be usable. Dozers reworked the shallow crossing area to prevent rafts from becoming beached. When the units convened for the rehearsal after action review, they decided to constrain the crossing to one centerline. The alternate site at the Corps of Engineers area would be used to launch bays and boats rafted downstream, relieving congestion on the centerline.

The Crossing

On the morning of 18 July, the river elevation was as projected and the crossing began. All the preparation and rehearsals fit together for the first time. As the assault force prepared, smoke drifted across the far shore, indicating that the pneumatic boats had received the order to move across the river. When the far shore was secure, the 814th Engineer Company began building rafts near the centerline. The 74th Engineer Company and the 2d Platoon, 586th Engineer Company, built rafts 3 kilometers upstream at the alternate site. Additional bays from the 74th were airlifted from Arrowhead Drop Zone to the centerline by C\158th Aviation Company.

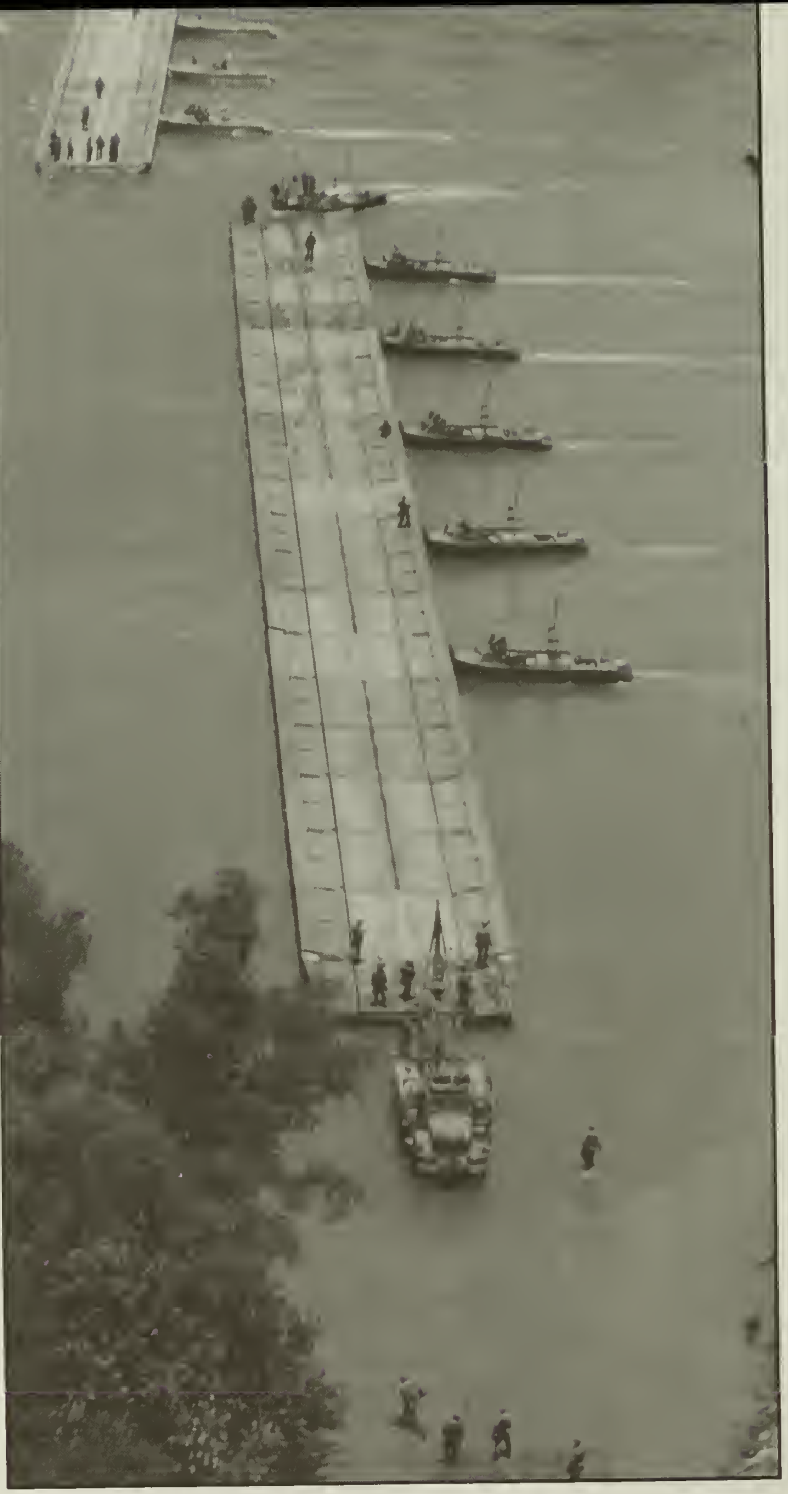
Rafts soon moved armored vehicles across the river and reinforced the far shore. At the same time, progress was slow on the bridge being constructed 300 meters downstream because of congestion at the centerline. Bays were rafted and launched in a jetty about 100 meters wide and 300 meters long. When rafts were being loaded, bridge launching ceased; when the rafting phase ended, the pace of bridge construction increased.

Three hours after construction began, the Arkansas River was bridged and the crossing site engineers requested traffic from the call forward area. Although the river was spanned with every available bay, vehicles had to travel through approximately 30 meters of shallow water before they could drive up the ramp bay. Within an hour, all traffic had crossed. The only actions that remained were to retrieve the bridge and identify the lessons learned.

Lessons Learned

Several lessons were learned and relearned during this exercise.

- Intelligence preparation of the battlefield is key to conducting successful river crossings. The crossing force engineer relied heavily on support from two nontraditional sources—civilians in the Corps of Engineers and the diving detachment. Without the forecast and hydrographic surveys indicating that the site would be crossable on 18 July, a limited exercise probably would have been conducted on Engineer Lake instead of on the Arkansas River.



Although the river was spanned with every available bay, vehicles had to travel through approximately 30 meters of shallow water before they could drive up the ramp bay.

- Automation speeds the planning process through use of spread sheets and Terrabase. Software needs to be standardized and shared.
- Close coordination is required at all levels of the operation. The 353rd Engineer Group and the 489th Engineer Battalion have a peacetime command relationship but still had difficulties meshing the brigade plan into the division plan. Most corps engineer groups and battalions are in the reserves, and bridging companies are split between Active and Reserve Components. Units must develop training relationships because there are few opportunities to train in the organization in which they will fight.
- A broad secure front is required. When too much activity was conducted around one centerline, operations were severely impacted and construction times doubled. There is a trade-off when working in training areas with limited resources.
- Rehearse, rehearse, rehearse. Even with the constrained working area, the bridging process would have been smoother if a full rehearsal had been conducted. Some problems identified during the bridging exercise could have been identified and resolved in a full rehearsal.

Engineers will rise to any challenge that confronts them. Even though the units had not trained together before the exercise, as soon as they hit the ground they became a team. As usual, active and reserve units at all levels integrated readily to complete the misison.

Concerns

Operation Chosin Action was successful, but several concerns still exist. Engineers must know who is responsible for planning river-crossing operations. Corps engineers demonstrated in this exercise that they possess the capability. But are divisions adequately concerned about river crossing? Since they have lost their bridging assets, do they even consider it a mission? Are there enough bridging assets in the inventory? Half of the bridging assets in CONUS were at Fort Chaffee, but there was barely enough bridge to cross a task force. These questions must be answered to ensure that we can fight and win on today's battlefields.

Major James K. Rupp is the S3 of the 353rd Engineer Group. He holds a bachelor of science degree in mechanical engineering from the University of Wisconsin and is a registered professional engineer.

The Multirole Bridge Company:
An Update

By Alan Schlie

Military history is replete with defeats (and victories) of armies backed against uncrossable chasms. And many heroes were made in assaults across those same chasms, into the face of a defending army. The crossing of chasms is a mission of U.S. Army engineers.

General George Washington escaped defeat and certain annihilation on Long Island in August 1776 by using soldiers from Colonel John Glover's 14th Continental Regiment (MA) as pontoniers to ferry 10,000 soldiers across the East River to Manhattan and safety. On Christmas Eve and again on New Year's Eve, Washington's soldiers and cannons were ferried across the Delaware River to surprise the Hessian garrison at Trenton. The pontoniers participated in both ground attacks before taking the prisoners and the victors back to Pennsylvania. Ever since, the Army's specialized river-crossing units and equipment have belonged to the pontoniers—the engineers.

Except for brief experiments with "India rubber" during the Civil War, bridging equipment for the horse-powered Army remained unchanged until the beginning of World War II. The introduction of tanks to the battlefield and the advent of armored tactics were the impetus for changing the pontoniers' equipment. The full-fledged mechanization of the Army created a need for bridging equipment to support increasingly heavy combat systems.

Factors for Change

Revisions to tactics, techniques and procedures (TTP), changes in training, and refinements to organizational structure always follow the introduction of new equipment. But recently other factors have affected TTPs, training, and organization:

- Restructuring the heavy division's engineering support moved all the bridging assets to corps level.
- The collapse of the Iron Curtain changed the Army's focus from a single threat to multiple threats.
- The use of military units in contingency operations.
- Force structure planning based on the premise of a power-projection Army capable of fighting two nearly simultaneous regional conflicts.
- Reductions in forward-deployed forces.
- Budgetary constraints that forced installation closures and the costly movement of stockpiled supplies.
- Consolidations that result when fewer

soldiers are left in military occupation specialties and the impact that teaching more skills has on available training time.

Efficiencies are gained by consolidating units with similar missions. When that assumption is coupled with the factors listed above, the decision to merge existing, single-role bridge units into a multirole bridge company (MRBC) is understandable. An MRBC will be significantly more versatile and flexible from both the operational and logistical perspectives than separate units. It will be trained and equipped to install or assemble all current and developmental U.S. Army system bridges. It will carry mixed sets of bridging as a "basic load" and expend that bridge as it supports the maneuver or assaulting forces, being resupplied when and where necessary.

The Plan

The MRBC process action team examined the impacts of doctrine, training, leadership, organization, materiel, and soldiers (DTLOMS) and concluded that a field evaluation was needed to "proof" the concept. The Test and Experimentation Command agreed to conduct the evaluation, and the 74th Engineer Company (AFB) from Fort Hood, Texas, volunteered to be the evaluated unit. The 586th Engineer Company from Fort Benning, Georgia, provided additional soldiers and equipment. The evaluation began on 20 July 1995, following the river-crossing operation of the 353rd Engineer Group at Fort Chaffee, Arkansas (see page 2).

Two 72-hour field training exercises provided opportunities to collect data to evaluate two issues:

- Can the MRBC headquarters effectively command, control, and communicate while providing bridging support?
- Can the MRBC be sustained in a combat environment while conducting continuous and simultaneous operations?

The evaluation mechanisms for issue one were the decisions made during operational planning and the information flow. The evaluation mechanism for issue two was the MRBC's operational readiness rate.

The Evaluation

The 74th reorganized under a test table of organization and equipment before the evaluation and was allowed time to become familiar with its newly acquired medium girder bridge. The new MRBC then deployed to a field location where it received bridging missions through both field training exercises. The company, the platoons, and sometimes the sections received missions to construct bridges and rafts at sites scattered across Fort Chaffee. Missions were executed during the day and at night to simulate battlefield conditions and provide the unit with data to evaluate their competence. Some sites were inaccessible because of flooding on the Arkansas River. That added realism complicated travel, bridging, eating, and sleeping schedules.

The evaluation was strictly for purposes of the Concept Evaluation Program (CEP) rather than a unit Army Training and Evaluation Program, but that did not distract the bridge builders' focus or reduce their intensity. When soldiers were asked to perform, the results were always "mission accomplished!" The unit was overloaded with missions, but there was no other way to determine the MRBC's capability to control and support its elements.

This concept evaluation substantiated the MRBC's ability to effectively command, control, and communicate while providing bridging support and to be sustained in a combat environment while conducting continuous and simultaneous operations.

The Future

The next step for the MRBC is to present this concept to a force development review panel at TRADOC to seek approval to create the new organization and implement it Armywide. The MRBC's multiple capability provides a synergistic impact on the mobility of the combined arms team. Each DTLOMS area will be positively enhanced through minor changes and will be firmly established when the next generation of bridging—the heavy dry support bridge and the improved ribbon bridge—is fielded.

With the completion of this CEP, the evolution of Army bridging has taken a significant step forward by demonstrating how the pontonier of the future will support Force XXI.

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Demystifying River-Crossing Operations

"Nature alone is often sufficient to foil a river crossing; if a crossing point is expertly defended, the slightest aggravation of terrain becomes a weapon in the enemy's hands. ...By their very nature, river crossings demand the coordinated action of several arms and branches whose roles are critical to tactical success. Yet even when fortune appears to favor one's own side, the potential for disaster in this, as in all military operations, is never far away".

Dr. Roger J. Spillar
"Combined Arms in Battle Since 1939"

Why do maneuver forces infrequently train for river-crossing operations? Part of the answer lies in the fact that many maneuver commanders and their staffs believe it is unlikely that the U.S. military will be forced to conduct a deliberate river crossing on the modern battlefield. In some respects they're correct, and we hope that the tempo of operations will not allow an enemy time to prepare a defense on a river.

This type of thinking is not new. After the Berlin Wall came down, maneuver commanders questioned whether we would ever have to conduct a deliberate breach again. But when Desert Storm and the possibility of a deliberate breach became a reality, the Army had to relearn combined arms breaching techniques. For that operation, we had time to train the force.

River-crossing operations are more difficult to conduct than deliberate breaches, and the skills at all levels are harder to maintain. As key players, engineers must reinforce the importance of training the combined arms team for river crossings and remove some of the mystery in planning and executing this important mission.

To demystify the terrain around a river, we must portray it in a way that is usable by the combined arms team. We do this by providing a digital terrain picture for the Army Battle Command System, requesting terrain products and providing detailed analyses of these for mission planning and rehearsals. As terrain experts, engineers play a critical role in the selection of assault crossing sites, supporting overwatch positions, support-by-fire positions, defilade routes, and assembly areas. We identify terrain that will support the employment of situational obstacles on flanks or on likely enemy counter-attack routes. As river and terrain conditions change due to weather or enemy action, we must continually update our maneuver forces' map data.

These requirements are not just Force XXI initiatives. We have always provided this advice, but Force XXI initiatives will help us do it more quickly and easily. The Engineer Officers Advanced Course trains captains to analyze terrain and give timely advice for mission planning. We must demonstrate our ability to portray terrain to the force so that commanders will feel comfortable about conducting this type of operation.

FM 90-13, *River-Crossing Operations*, provides the doctrinal basis for planning and conducting river crossings. However, some confusion exists in the engineer community about the planning responsibility of the division engineer and the corps engineer group commander. This legitimate concern is often expressed by the maneuver commander and his staff.

The answer is that the division engineer has overall responsibility for planning the river crossing and coordinates for corps engineer units to cross the force. The division engineer begins planning immediately after he receives a warning order or when mission analysis determines the need to cross a river. Through parallel planning and providing input to the maneuver plan, the division engineer helps eliminate delays in the planning process at division headquarters or in the engineer brigade. When the engineer group commander and his staff link up with the division engineer, initial and critical engineer input already is incorporated in the maneuver plan.

The two engineer staffs then develop a detailed crossing plan that supports the maneuver plan. Therefore, the relationship between the division engineer and the engineer group commander in the planning process is mutually supporting and mission-oriented. The engineer community must clarify these relationships by educating commanders and staffs through officer professional development and command post exercises.

How does the engineer corps demonstrate flexible command and support relationships that take into account a fast-moving modern battlefield? River-crossing operations are an ideal opportunity to show maneuver commanders the advantages of massing engineers. Traditionally, the command and control of engineer support for the

(Continued on page 19)

By Major Glenn Fenton

Engineer Battlefield Assessment:

The Good, the Bad, and the Ugly

By Michael W. Sayer

This is the first in a series of three articles about the roles of NCOs in an engineer battalion of a heavy division.

"Tell me what you know about EBA," said my battalion commander.

I was dumbfounded. "EBA? What does this refer to, sir?" I asked.

"Engineer battlefield assessment," he replied.

Thus began my introduction to a topic that was to drive my field duties for the next two years.

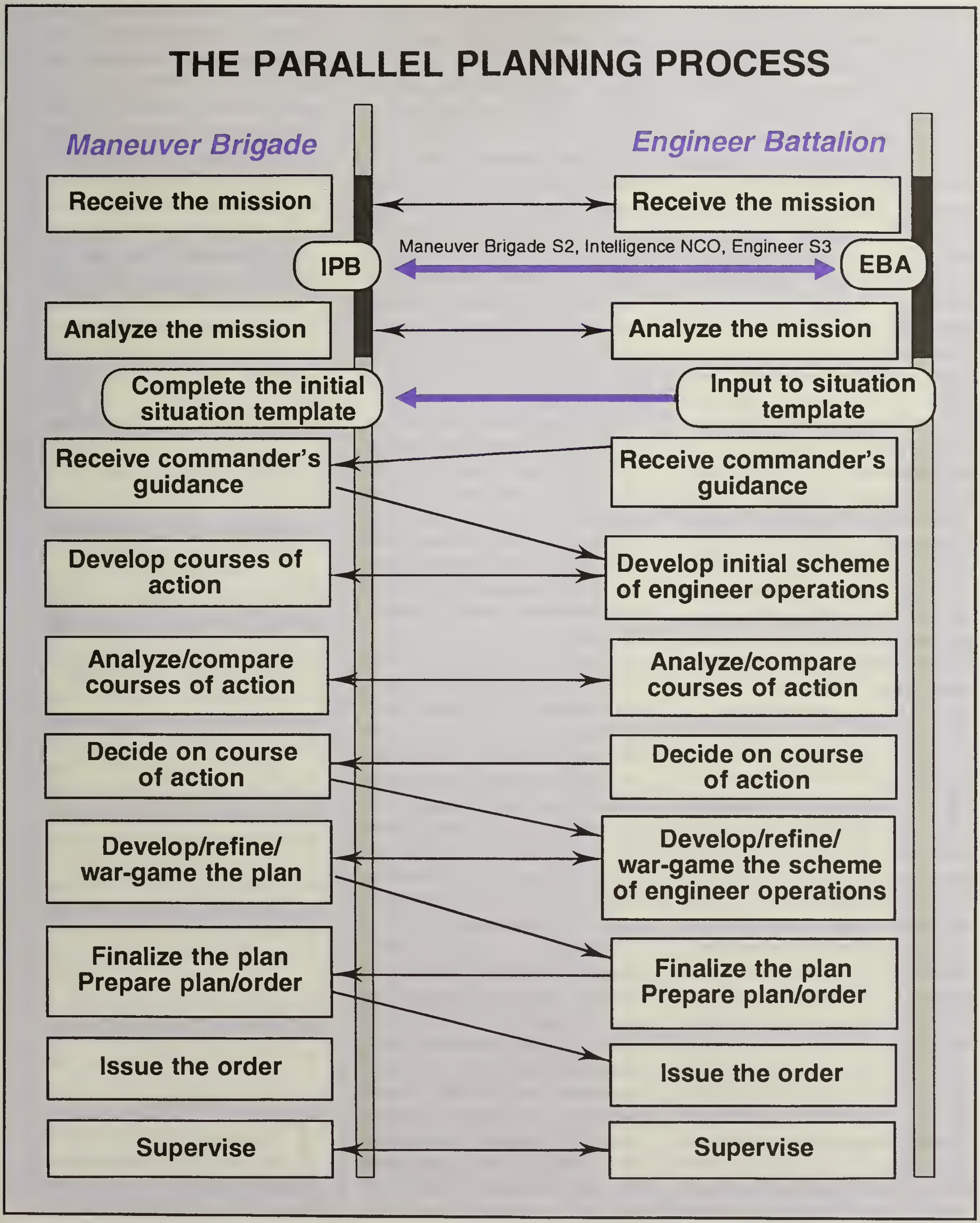
When the 4th Engineer Battalion transitioned under the Engineer Restructure Initiative (ERI) in 1992, I inherited a job that no other 12B30 I knew of had filled—the position of intelligence NCO. The ERI made critical personnel changes. Its modified table of organization and equipment (MTOE) eliminated the intelligence officer/S2 position and replaced it with an engineer master sergeant (12Z50) position. Since master sergeants are usually in short supply in a battalion, I got the job. As part of my professional development, I read FM 34-130, *Intelligence Preparation of the Battlefield*, but my knowledge was still cursory. The assignment opened my eyes and broadened my perspective considerably.

At first glance, the EBA seems like nothing more than an engineer using the intelligence preparation of the battlefield (IPB) process. But this reasoning misses the purpose of EBA, which is to complement and broaden the IPB process. Literally, EBA is an analysis by engineers that concentrates on the effects of terrain, weather, and the enemy on the battlefield.

Terrain Analysis

Terrain is the bedrock on which all operations rest. Mobility, trafficability, vegetation, and terrain determine how difficult an operation will be. In addition to analyzing soil types and cross-country mobility, we must consider the effects of these factors on operations. When a brigade commander plans a defense in sector, he must use all of the terrain visualization tools available. Some of the tools currently used by the division terrain team are the Multi-Spectral Imagery Processor (MSIP) and Terrabase. These software programs provide terrain visualization information that give users a feel for what the area of operation looks like. The division terrain team uses cross-country mobility and trafficability overlays, aerial photos, and satellite imagery. They also keep bridge reconnaissance information, assorted overlays, and 1:25,000 scale maps. While terrain teams have access to various scale maps, selection of the proper scale depends on the mission, equipment, time, troops and terrain (METT-T). For example, in a mechanized brigade movement to contact, a 1:25,000 map is of limited use, but in a light infantry raid, it is extremely valuable.

Engineers look at all of these products to provide the maneuver S2 with a terrain analysis that is in greater depth than the restricted and severely restricted evaluation commonly performed. By using the parallel planning process shown in the figure on page 13, we bring the battlefield operating system (BOS)



THE PARALLEL PLANNING PROCESS

Maneuver Brigade
Engineer Battalion
Receive the mission
Receive the mission
Maneuver Brigade S2, Intelligence NCO, Engineer S3
IPB
EBA
Analyze the mission
Analyze the mission
Complete the initial situation template
Input to situation template
Receive commander's guidance
Receive commander's guidance
Develop courses of action
Develop initial scheme of engineer operations
Analyze/compare courses of action
Analyze/compare courses of action
Decide on course of action
Decide on course of action
Develop/refine/ war-game the plan
Develop/refine/ war-game the scheme of engineer operations
Finalize the plan Prepare plan/order
Finalize the plan Prepare plan/order
Issue the order
Issue the order
Supervise
Supervise

input to the war-gaming process and integrate it in the time-space-purpose analysis of all previously identified factors.

If a unit is to defend in sector, soil composition is critical information. When the commander plans a defense using natural obstacles such as drainage or slopes, he needs to know about the surrounding terrain. Whether the soil is a silty clay or hard rock influences his choice of battle positions and whether he will fight dug in or above ground. Because the soil type directly affects engineer effort, it must be identified early in the planning process. Without such information, precious blade and platoon hours may be lost during the defensive preparation. An EBA terrain analysis depends on an immediate and accurate depiction of the terrain in the area of operations; additional analyses are required to complete the EBA.

OCOKA

The process of observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA) provides additional depth and breadth of information on the military aspects of terrain. A brief discussion of OCOKA follows; for more detail, refer to FM 34-130.

Observation and Fields of Fire. Observation is the ability to see either visually or through surveillance devices. Because cover and concealment limit direct observation, engineers (the brigade terrain experts) have assets that provide detailed horizontal line of sight (LOS). Soldiers use LOS when they emplace surveillance and communications assets, such as Q-36 and Q-37 radars and retransmission sites. When a commander is forced into a hasty defense, Terrabase provides LOS and visable area plots from selected locations that help him visualize terrain and engagement areas. LOS products also help emplace intercept units' baselines and locate laser designators. A field of fire is the area a weapon or a group of weapons may effectively cover from a given position.

After engineers analyze the surrounding vegetation, elevation, and man-made objects, they make an overlay that delineates locations used to evaluate observation and fields of fire. They use the overlay to determine the effects of observation and fields of fire on the plan.

Cover and Concealment. Cover is protection from fire; concealment is protection from observation. Engineers provide recommendations to the commander about defensible terrain, approach routes, and assembly areas. Adding cover and concealment information to that already plotted on the overlay increases its effectiveness in the planning process.

Obstacles. Obstacles are natural or man-made terrain features that stop, impede, or divert military movement. They are the engineer's prime responsibility, and we must determine the effects of each obstacle on the force. Obstacle systems emplaced perpendicular to the line of march favor the defense and those emplaced parallel favor the attacker. Vegetation, surface drainage, surface materials, slopes and gradients, natural and man-made obstacles, transportation systems (such as bridges and roads that are classified as restricted due to curves, slopes, or width), and the effects of weather are factors affecting obstacle effectiveness. Annotate the effects of these factors on the overlay to produce a combined obstacle overlay.

Key Terrain. Key terrain provides a marked advantage to its holder, but decisive terrain is necessary to accomplish a mission. A hilltop overlooking the valley containing the objective is key terrain. The pass leading past the hill that is the only route to the objective is decisive terrain. Annotate these factors on the overlay.

Avenues of Approach. Avenues of approach are determined from information plotted on the overlay. First, identify areas that canalize movement due to terrain constriction; these are mobility corridors. Then see if the corridors are wide enough to move tactical formations two echelons below your level. After identifying the corridors, categorize them by the size or type of force they will accommodate. When the mobility corridors are grouped, they form avenues of approach. These avenues must provide ease of movement and enough width to allow the force to pass. When this information is plotted, the result is the Modified Combined Obstacle Overlay (MCOO).

MCOO

The benefits of an MCOO become apparent when a planning process begins. Because it is produced before deployment or just after arrival in theater, the MCOO is immediately available for planning.

With the MCOO, it is unnecessary to repeat the entire analysis process each time a mission is received. It also allows a greater depth of analysis.

Engineers analyze the areas of OCOKA, factor in the weather, and then determine their effects on friendly and enemy maneuver. By comparing the advantages and disadvantages of various plans, we can focus early in the process and provide a timely and accurate product for the fight. To be effective, engineers must thoroughly understand the enemy's capabilities.

> "It is impossible to overstate the need to know everything about the enemy in general and enemy engineers in particular."

Enemy M/CM/S Capabilities

For the engineer staff, this is the point where the intelligence NCO is critical. It is impossible to overstate the need to know everything about the enemy in general and enemy engineers in particular. The intelligence NCO has support from the S3, the XO, and the commander, but he must be the subject matter expert. He must work closely with the S2s from the engineer and the maneuver brigades and make accurate deductions from the available data.

Specifically, the intelligence NCO must be able to state the mobility/countermobility/survivability (M/CM/S) capabilities of the enemy and incorporate them in the planning process. For example, if the intelligence NCO knows the enemy can breach six obstacles, he must emphasize that the friendly unit needs seven or more obstacles. If enemy doctrine calls for antitank ditches, the bridging assets must be in a forward position.

The intelligence NCO is the threat engineer subject matter expert. To help in war gaming, he advises the assistant brigade engineer about the enemy impact on the operation and describes the most likely method of enemy engineer employment. As with all brigade intelligence products, he coordinates his input through the brigade S2. The intelligence NCO works with the targeting cell to identify high-value targets as well as high-payoff targets. In the war game, he also identifies the high-payoff targets, explains their location and significance, and identifies M/CM/S-specific priority intelligence requirements. In the offense, he ensures that the templated obstacles are on the reconnaissance and surveillance plan and in the operations order. He also addresses the enemy's weaknesses and vulnerabilities to help determine how to overcome them.

Given a solid understanding of the enemy and connections to the division's intelligence pipeline, the intelligence NCO will provide the following information about the enemy engineer order of battle.

Identification. The intelligence NCO must know who the enemy is. He must determine if the enemy engineer unit is organic or attached from a different echelon. Is it regimental, divisional, or pushed down from corps? By going through intelligence reports, he can learn who we are facing, from echelons above corps through separate brigades and battalions. If operating in a semiarid, desert climate, sighting bridging units forward may be insignificant. However, if reports state that corps-level breaching assets are moving forward, this information may be important.

Composition and Strength. This information is extremely valuable. For example, if the enemy MTOE calls for one dozer per battalion, units are unlikely to dig in. However, if the enemy has mine-laying equipment and ditching machines, the defense will be stronger and harder to overcome. The friendly order of battle is significantly different when the enemy strength is at 90 percent than when it is at 50 percent.

Disposition and Location. The enemy will try to use the terrain to his advantage to support his scheme of maneuver. By knowing the habitual type of support provided by an enemy engineer unit to its maneuver force, we can predict enemy engineer activity fairly accurately. With this knowledge, engineers can determine a probable scheme of maneuver and support.

Recent and Known Activities. Being tied into the intelligence pipeline becomes critical at this point. When spot reports indicate enemy activity, such as breach rehearsals or routine maintenance, we can use that information to forecast upcoming actions.

Capabilities. This is the meat of the intelligence NCO's responsibilities. The enemy's capabilities are fairly apparent when we know the unit's identification, composition, strength, disposition, location, and recent activities. By combining this information with his doctrine, we can answer the following questions:

- What support will enemy engineers provide to their reconnaissance?
- What are the enemy's mobility capabilities?
- What are the enemy's countermobility capabilities? Does he employ conventional obstacles, scatterable mines, and/or tactical and protective obstacles?
- What are the enemy's survivability capabilities? Does he rely on vehicle fighting positions or fortifications, trenches, and bunkers?

Probable Courses of Action. After war gaming the enemy's possible courses of action, determine the most likely course of action of his engineer assets based on his M/CM/S capabilities. Identify when and where enemy M/CM/S assets are expected, specifying the time/space/purpose matrix on the battlefield. Then determine the effects of enemy actions on friendly forces and our maneuver or defensive plan. Given what we know of the enemy and our counteractions to his reactions, we can exploit weaknesses or vulnerabilities identified during the EBA process.

Friendly M/CM/S Capabilities

The final part of the EBA process is to evaluate the friendly engineer mission and M/CM/S capabilities and their impacts on mission accomplishment. The S3 and assistant brigade engineer provide most of the information, based on statistics taken from reports companies send to the battalion headquarters.

EBA and the Maneuver Brigade

The ERI battalion's working relationship with the maneuver brigade is sometimes hampered because of problems in three areas:

- Personnel assignments.
- Execution, integration, and acceptance of the EBA process.
- Understanding of the EBA process.

Personnel Assignments. Engineers often assign soldiers to the intelligence NCO position who have neither the training nor the experience needed for the job. Frequently, a soldier who is probably a superb leader and motivator is thrust into a position for which he is unprepared, causing a tremendous disservice to three elements.

- The soldier, who cannot perform his assigned mission because the noncommissioned officer education system does not train 12B NCOs for this difficult and demanding position.
- The battalion, which must spend considerable time bringing this soldier up to speed. Typically, NCOs go back to line units at the end of 12 to 18 months, before they have developed into effective team players.
- The brigade, which has a weak link in a critical battlefield operating system of the brigade combat team.

There are solutions to these problems. The Battle Staff Course is helpful, but there are few allocations for engineer battalions. NCOs may rotate to the line before receiving this training. I recommend that this position be a two-year assignment to give soldiers time to learn the job. Additionally, the position requires an expensive high-security clearance, which takes from six months to a year to complete; the cost cannot be justified for short-term assignments. I recommend that the 12B Advanced NCO Course be modified to provide time (40 hours minimum) to introduce NCOs to the requirements of this position. The additional training time will allow prospective intelligence NCOs to become knowledgeable about this nontraditional 12B job.

Execution, Integration, and Acceptance. Brigade S2 sections often do not understand how the EBA process supports the total IPB process. Some S2 personnel think that engineers are only trying to add another product to the orders process. Since intelligence NCOs are not from the military intelligence field, they must prove themselves and the value of their product to the S2 section. Time will solve this problem.

(Continued on page 49)

CMF 12 Advanced Noncommissioned Officer Course Program of Instruction

By Sergeant First Class John Hurley
and Sergeant First Class Steven Eberharter

During the past two years, the National Training Center analyzed the present and future training needs of NCOs to determine their battlefield requirements, responsibilities, and duties. From this analysis, the Combat Training Centers and the Center for Army Lessons Learned concluded that—

- NCOs have the technical skills required to perform missions tasked.
- NCOs lack the tactical skills required to perform missions tasked.
- The NCO's role on the battlefield is not clearly defined in doctrine or in the units.
- Future doctrine must include NCOs as tactical assets on the battlefield.
- The NCO's knowledge must complement the officer's knowledge to build a more cohesive team.

Shortcomings in the NCO's ability to accomplish battle tasks relate directly to the lack of institutional and unit training required for those tasks. TRADOC Regulation 351-10, *Guidelines for the Development of Enlisted Training*, states that the Advanced Noncommissioned Officers Course (ANCOC) and the Officers Basic Course should integrate training of common level tasks. The tasks should be those that both NCOs and officers must perform.

The U.S. Army Engineer School established a new, interim program of instruction (POI) based on conclusions from the two-year analysis and the requirements of TRADOC Regulation 351-10. In addition to the integrated tasks mentioned above, this POI includes common leader training required by the U.S. Army Sergeants Major Academy and technical training required by the Engineer School. The interim POI will be tested and validated during the FY96 course period.

So that future ANCOC students and their supervisiors can become familiar with requirements of the new course of instruction, the NCO Academy developed Student Advance Sheets and sent them to all commands. They addressed the following lessons:

- Provide Engineer Support to Army Operations
- Plans and Orders
- Breach an Obstacle
- Conduct Engineer Tactical Planning
- Task Force Engineer Responsibilities and Duties
- Determine Engineer Capabilities
- Provide Engineer Support to Offensive Operations
- Conduct Offensive Operations Practical Exercise
- Conduct Offensive Operations TEWT
- Provide Engineer Support to Defensive Operations
- Determine Tactical Obstacle Requirements
- Conduct Defensive Operations Practical Exercise
- Conduct a Defensive Operations TEWT
- Conduct Offensive Operations
- Conduct Defensive Operations
- Obtain Combat Service Support
- Determine Division Organization
- Conduct River-Crossing Operations

Battalion command sergeants major and senior NCOs must ensure that scheduled ANCOC students within their command are aware of the new POI and have copies of the Student Advance Sheets. When trained to standards in the new POI, the NCO's tactical skills will become a critical asset on the battlefield.

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Personal Viewpoint

Tiered Readiness and Resident Schooling in the Reserve Components

By Brigadier General Thomas Whitecotton

Many Army combat engineer leaders are concerned about the large number of Reserve Component (RC) senior captains who have not completed the Combined Arms Service Support School (CAS3). Lack of this schooling may eliminate some fine soldiers from competing for promotion. The problem stems primarily from three roots:

- The recently implemented criteria requiring CAS3 for promotion to major. For the RC, this criteria took effect in October 1994.
- The dwindling combat support force structure, which causes some RC engineer units to continually deploy and redeploy while other units do not deploy.
- The zealous attitude of some dedicated captains, who have consistently performed missions beyond the point of reasonable personal sacrifice. Many captains delayed going to CAS3 in favor of numerous deployments; now their promotions or careers are in jeopardy.

We can solve this problem by applying resources at the right time and place and by putting mechanisms in place to ensure that our best and brightest captains survive the ongoing Army force structure downsizing. The following discussion is based on my experience as an RC commander, but I'm aware that similar problems are emerging in Active Component units.

Background

In the force structure of the U.S. Army, units are arrayed according to their relative priority as reflected in the war plans of the Commanders in Chief. Ultimately units appear in the Forces Command time-phased force deployment list (TPFDL). Force activity designators (FADs) assign each unit a numerical priority for resources, including schooling.

In the past, the relative priority for individual schooling was a distinction without a difference. Adequate training dollars ensured that officers and noncommissioned officers (NCOs) attended both basic and advanced courses. Professional development for officers continues with either resident or corresponding studies options for CAS3 and the Command and General Staff College (CGSC). Next is the Army War College (AWC), which is very selective, with attendance based on the "best qualified with most potential for advancement" criteria. That distinction separates the AWC from the mass-production environment of preliminary military schools. Today, the selection criteria for CGSC appears to be approaching that of the AWC.

The best-qualified selection criteria for AWC and CGSC may become the standard for attendance at other Army officer and NCO courses. Attendance qualifiers may be needed because of large reductions in school resource accounts. Such funding cuts cause readiness "tiering" by separating units into several resource categories based on their TPFDL priority.

Tiered Readiness

Tiered readiness is the concept some in the table of organization and equipment (TOE) Army call the "have" and the "have not" units. Contingency Force Pool (CFP) (soon to be Force Support Package) units are "haves." They deploy early and are required to maintain the force structure needed to fight two simultaneous major regional contingencies. These units are funded at 100 percent of optimum tempo (OPTEMPO). In the reserves, CFP units have priority for personnel. They are authorized to be at 100 percent (or more) of TOE strength, have priority for recruiting, and maintain 100 percent of their full-time unit support (FTUS) personnel. Most importantly, CFP units have priority for attendance at military schools, including CAS3. A proposal under discussion is to modify the Army Training Requirements Resourcing System (ATRRS) to ensure that quotas for needed courses are given first to soldiers in CFP units.

Tiered readiness works! In my CFP units, funds are distributed according to the model, with expanded FTUS support and increased OPTEMPO. The additional training time and operation readiness evaluation (ORE) preparation in these units results in their increased readiness.

As units are arrayed in priority from CFP I through enhanced brigades to CFP II units, maneuver brigades, and divisions, and then to "all other units," resources for units not in the upper echelons are cut severely. The "all other unit" status means they have low FADs, 50 percent FTUS support, an 85 percent ceiling of TOE fill, 60 percent OPTEMPO, and no priority for schooling. With fixed or declining budgets, the cuts become more serious.

While the tiered readiness system is emerging, there is also turbulence in the force structure, constant change in TPFDLs, and declining balances in school and training accounts. Large deployments and training exercises, such as Reforger and Team Spirit, have been severly cut. School accounts today have less than one-third of the funding they had just two years ago. Man-day expenditures to support overseas deployment training have been drastically reduced in RC units.

Impacts on Schooling

Two years after record levels of participation in training exercises, RC units now participate in the minimum training opportunity required (i.e., authorized inactive duty training and a 15-day annual training (AT) period). The extra AT periods and man-days used to send people to resident schools are rapidly evaporating. There is bitter irony: Our collective training OPTEMPO has declined, allowing soldiers to attend required courses, but we now lack sufficient training funds to meet course demands.

The Fix

Army leaders must commit time and dollars now for our hard-charging captains to attend CAS3 so they remain competitive for promotion to major. The care factor is reciprocal. We must accommodate those who did double duty to deploy, took the risks, completed the missions, and redeployed year after year. Without additional paid man-days, officers must attend CAS3 on their own time.

As we adapt to declining structure and resources, other challenges will limit the number of RC soldiers attending schools. The select, train, promote, and assign (STPA) system provides "order of merit" lists for officers and NCOs. The STPA concept uses these lists to invest schooling dollars only where the potential for success is high. This concept introduces competition for available school quotas in a system where no competition existed before.

Tips for Commanders and Captains. The following suggestions may help RC units allocate their shrinking training resources:

- Throughly review the order-of- merit lists, ensure their accuracy, and use them to prioritize individual training requirements.
- Pressure captains to complete CAS3. Fort Leavenworth has increased the capacity of CAS3 courses to accommodate expected student loads. The U.S. Army Reserve Force school system has scheduled extra CAS3 sessions in FY 96; they are soliciting students.
- Ensure that each officer has consulted his or her mentor and has developed a plan to complete required military courses.

Institutional Training Challenge. The Army's Training and Doctrine Command (TRADOC) needs to explore alternatives to the current RC CAS3 course format. RC officers interrupt their civilian careers to attend both the Engineer Officer Basic and the Advanced Courses (EOBC and EOAC). Now they must take additional time off for CAS3 and CGSC. It is increasingly difficult for RC officers to remain employed, serve in the ready reserve, and attend required courses in the formats that worked 20 or 30 years ago. TRADOC must adapt school formats to the needs of today's customers. A few ideas are—

- Integrate EOAC and CAS3 at the branch school and teach CAS3 as a follow-on to EOAC.
- Export CAS3 as interactive CD ROM.
- Drop the CAS3 requirement. Before CAS3, senior National Guard captains were expected to enroll in CGSC and complete the course under mentoring by experienced staff officers at their engineer battalion, group, or brigade while they served in a staff assignment through the rank of major. Perhaps it is time to reinstate that concept.

There is a price to pay for achieving enhanced readiness for CFP units at the expense of the rest of the force. Our captains are paying that price now in schooling. It may be heroic to say that all units can maintain their current readiness requirements under severe resource restraints, but practically we know that tiered readiness will cause degradation in many units unless we take action!

BG Whitecotton is Brigade Commander, HHC, 35th Engineer Brigade (Corps), Missouri National Guard. He has served in numerous assignments in both the Active and Reserve Components, including Korea and combat duty in Vietnam.

(Continued from page 11)

maneuver fight was separate from the support force mission. As we move toward Force XXI, the ability of the engineer commander and his staff in the engineer brigade headquarters to command and control additional assets will improve significantly.

In this scenario, the engineer brigade could conceivably command and control two or three corps engineer battalions with multirole bridge companies to cross the division and still support the maneuver fight. The concept of massing engineers on the battlefield is discussed often at the U.S. Army Engineer School, but we must demonstrate this ability to our maneuver brethren. One solution is for engineer participants in the Command and General Staff College exercise, Prairie Warrior '96, to mass engineers under the engineer brigade when they conduct river-crossing operations for the Mobile Strike Force.

Maneuver commanders will be interested in river crossings if engineers demonstrate that we can portray terrain accurately, that we understand our doctrine, and that we can tailor our flexible command and support relationships for specific missions. Advanced Course graduates are better trained in terrain visualization now than ever before. We must use them to demonstrate these capabilities. Let's keep education, doctrine, and debate on river crossings alive!

Major Fenton, the Australian exchange officer at the Engineer School, is chief of the Engineer Officer Advanced Course Division in the Department of Tactics, Leadership, and Engineering. Previous assignments include a two-year exchange with the 65th Engineer Battalion, 25th Infantry Division (Light), Schofield Barracks, Hawaii.

WANTED

U.S. Army Engineer Divers

By Sergeant First Class Timothy Dillard and Master Sergeant Peter Swenson

Enemy sabotage and artillery deny the use of strategic ports. Harbors are jammed with sunken ships and downed aircraft. Underwater obstacles block advancing forces at river-crossing sites. Resupply efforts and mobility are halted. Rapid obstacle reduction and harbor clearance are vital, but who is trained, equipped, and available to quickly respond to support these critical engineer underwater missions? U.S. Army engineer divers!

* * *

"Be all you can be" is a slogan that has enticed many young soldiers into the U.S. Army. Behind this often-repeated phrase is an important question that anyone seeking a challenge or a change must ask. "What am I capable of accomplishing if I apply myself?" No one will take you by the hand and set goals for you. That is an individual responsibility. The only way to find the answer is to seize opportunities that present themselves. Becoming an Army engineer diver is one such opportunity.

The Army is looking for highly motivated soldiers to volunteer for engineer diver training, Military Occupational Specialty (MOS) 00B. Though divers have been a specialty within the Army for many years, the MOS is not well-known. This article answers some common questions about the diving field and what it takes to apply.

Missions

Engineer divers support all specialized underwater missions in communication and combat zones. In May 1995, the Engineer School's Directorate of Combat Developments prepared an Executive Summary *U.S. Army Concept for Engineer Diving Forces* that describes these missions.

Communication Zones. Divers provide sustainment engineering support in communication zones:

- Furnish combat swimmer, scuba, and surface-supplied diving assets to commanders in ports, harbors, and coastal zones.
- Construct port and logistics-over-the-shore structures, facilities, and floating barriers.
- Repair damaged piers, docks, wharfs, seawalls, and breakwaters.
- Clear and mark navigational waterways.
- Collect underwater terrain and structure data.
- Remove underwater obstructions.
- Reduce and emplace underwater obstacles, mines, and demolitions.
- Recover soldiers and materials.
- Install and maintain mooring systems and off-shore petroleum and water-distribution systems.
- Repair Army lighterage and vessels.

A diving crew aboard an LCU 1542 Malados diving platform in Pohang, Korea, perform maintenance on the ship's mooring system.

- Protect land forces, vessels, and underwater structures from underwater threats.
- Reduce the probability of damage to underwater structures.

Engineer divers proved their importance during Operations Desert Shield/Desert Storm. Except for one lightweight diving team in Panama, all active duty engineer diving units directly supported the conflict. They logged more than 1,000 hours of bottom time in five ports throughout Saudi Arabia and Kuwait. Other recent overseas missions include operations in Somalia and Haiti and harbor clearance in the hurricane-stricken Caribbean islands.

Combat Zones. Engineer divers provide support to maneuver units during river-crossing operations in forward combat zones:

- Cross wet-gap obstacles while minimizing losses.
- Perform bottom and bank approach surveys of proposed river-crossing sites.
- Locate, mark, and neutralize underwater obstacles using mechanical or underwater explosive methods.
- Assess bridge damage.
- Make in-water repairs to bridges, dams, pipelines, canals, and levees.
- Construct underwater bridge structures, obstacles, and floating barriers.
- Search for and recover water casualties and equipment.
- Clear and mark inland navigational waterways.
- Place underwater explosives on bridge supports to deny enemy use during retrograde operations.

Army engineer divers are the only diving teams in the Department of Defense that are trained and equipped to accomplish these missions. The Commander in Chief's reply to the 1992 Army Engineer School evaluation of Army diving and the performance of lightweight diving teams in Operations Desert Shield/Desert Storm and Operation Restore Hope confirm that these tasks are essential.

Professionalism

Within the engineer diving community, hard work and the desire to excel are the rule rather than the exception. Soldiers in the Army diving field are among the most professional in the military. Those who earn and wear the diver's badge understand and accept the responsibility that another person's life may depend on their ability to perform their job, not only in the stress of combat but on a daily basis during routine operations. Divers earn a paycheck by placing underwater explosives to flatten a sunken vessel that is obstructing ship traffic and by crawling inside the wreckage of a downed aircraft at depths of 190 feet, in total darkness, to recover equipment or casualties. These tasks require confidence in yourself, your team, and your equipment. Mutual trust and respect are the basis for the strong sense of camaraderie and esprit de corps that exist in all diving detachments.

Entry Requirements

AR 611-75, *Management of Army Divers*, lists entry requirements for MOS 00B and contains the *Engineer Diver Application* (DA Form 5030-R). The specialty is open to all soldiers, regardless of MOS or gender, who meet the requirements listed in the table on page 22.

Engineer Diver Requirements

Entry Requirements

- Be between 18 and 30 years old.
- Be in the grade of private through specialist with less than one year time in grade (engineer officers, second lieutenant or first lieutenant).
- Be in a nonpromotable status when reporting for diving duty.
- Score 100 or higher on the general mechanical test of the Armed Services Vocational Aptitude Battery (ASVAB).
- Score 110 or higher on the general technical or skilled technical test of the ASVAB.
- Have no conviction of illegal substance abuse.
- Have a physical profile of 111111.
- Undergo a diver medical examination and meet the medical fitness standards prescribed in AR 40-501 and AR 600-9.
- Attain a minimum score of 240 (minimum of 80 points per event) on the Army Physical Fitness Test.
- Pass the Diver Physical Fitness Test in the following sequence:
  - Swim 500 yards in 14 minutes or less, using the side stroke and/or breast stroke. Rest 10 minutes.
  - Perform 42 continuous push-ups in 2 minutes or less. Rest 2 minutes.
  - Perform 50 continuous sit-ups in 2 minutes or less. Rest 2 minutes.
  - Perform 6 continuous pull-ups with the palms facing away from the body. Rest 10 minutes.
  - Run 1 1/2 miles in 12 minutes 45 seconds or less.

Application Forms

- DA Form 4187, *Request for Personnel Action*, indicating your desire to reclassify as an MOS 00B, Engineer Diver.
- DA Forms 2A and 2-1, *Personnel Qualification Record*, Parts I and II.
- DA Form 5030-R, *Engineer Diver Training Application*, signed by the commander.
- DA Form 705, *Army Physical Fitness Test Scorecard.*
- SF 88 and 93, *Reports of Medical Examination and History*, (originals).
- Bonus, Extension, and Reenlistment Program application, if applicable.

Application Packet

Application packets vary slightly but usually include the forms listed in the table above. Waivers may be considered for some vision or hearing requirements and for up to two years time in grade as a specialist.

The Surgeon General's office has changed the reviewing procedures for physicals. DA Form 5030-R, Part I, *Submission of Applications*, has a new "TO" address: Aviation Medical Consultant to the Surgeon General, U.S. Army Safety Center, Building 4905, 5th Avenue, Fort Rucker, Alabama 36362-5363. Send the entire application package to this address by registered mail. Include a memorandum requesting that the packet be forwarded, upon approval, to the appropriate Personnel Command department listed on DA Form 5030-R. Keep a copy of the application for your files.

Prequalification Course

Candidates accepted into the diving program receive orders to report to the U.S Army Diving Detachment (Provisional), Fort Eustis, Virginia, to attend the 10-day Diver Prequalification Course. It is both physically and mentally demanding, which allows the instructors to evaluate the candidate's ability to meet the physical, mental, and academic challenges presented during second class diver training.

The curriculum includes instruction in underwater physics, physiology, diving medicine, and dive charting. Instruction of academic material starts at a beginner level with the assumption that the candidate has never seen the material before. Comprehension and retention are tested by a written examination.

Candidates must demonstrate their level of fitness during extensive physical training and by their performance on the Army and the Diver Physical Fitness Tests. Physical training, conducted twice daily, emphasizes pool training (swimming and treading water), running, pull-ups, push-ups, flutter kicks, leg spreaders, and abdominal exercises. When reporting to the Prequalification Course, it is wise to be in excellent physical condition, well above the minimum entry-level requirements.

Candidates must perform an indoctrination dive using surface-supplied (hard hat) diving equipment. A pressure-tolerance test is administered to determine if they can adjust to ambient pressure changes. Individuals who cannot adjust are rare. Successful completion of the Prequalification Course is required to attend the second class diver training.

Second Class Diver Course

This 20-week course is conducted at the Naval Diving and Salvage Training Center in Panama City, Florida. Students receive instruction in diving physiology, medicine, and physics; the operation and maintenance of scuba, surface-supplied diving systems, and recompression chambers; underwater demolitions, cutting and welding, hydraulic tools, and photography; and marlinespike seamanship, rigging, and basic salvage.

Soldiers receive scuba training at the Naval Diving and Salvage Training Center, Panama City, Florida.

Graduates receive the MOS 00B and the second class diver's badge and become eligible for hazardous duty incentive pay. The diving school teaches confidence in the equipment and how to use that equipment to reach the work site. From the first assignment, an engineer diver learns to be productive in the water and to gain the experience needed to progress as a diver.

Levels of Expertise

Four levels of Army diving expertise are recognized by the award of diver rating badges: second class diver, salvage diver, first class diver, and master diver. As a diver advances in rank, he must advance in rating or be reclassified out of the field.

Second Class Diver. To receive this rating, a candidate must meet entry prerequisites and successfully complete the Prequalification Course and the Second Class Diver Course.

Salvage Diver. A diver must have performed satisfactorily as a second class diver for at least 18 months, be a specialist in a promotable status or a sergeant assigned to a salvage diver position, be able to perform as a salvage diver, be recommended by a master diver, and have passed the Underwater Construction Technician Basic Course to receive this rating.

First Class Diver. A candidate for this rating must have performed satisfactorily as a salvage diver for at least 3 years, be a sergeant who has attained promotion status or who becomes a staff sergeant while assigned to a first class diver position, be able to perform as a first class diver, be recommended by a master diver, and have passed the Basic Noncommissioned Officer Course and the First Class Diver Course.

Master Diver. To receive this rating, a diver must have performed satisfactorily as a first class diver for at least 3 years; be a staff sergeant who has attained promotion status or a sergeant first class; have passed the Advanced Noncommissioned Officer Course, the Underwater Construction Technician Advanced Course, and the Army Master Diver Certification Course.

"Be All You Can Be"

The limited assignment locations (Fort Eustis, Virginia, and Fort Shafter, Hawaii) and small number of engineer divers (approximately 90) create an environment where individual strengths and weaknesses are well-known and which encourages teamwork to overcome these weaknesses and build on strengths. The success of every mission directly depends on each soldier's contribution to the team–from the newest second class diver to the most senior master diver. The nature of the profession and the pride in being part of the Army diving community provide a strong incentive to "Be all you can be" and inspire supervisors and subordinates to perform to the best of their abilities.

The Army Engineer Diving Program gives qualified applicants the opportunity, training, and support necessary for success. The desire and determination must be yours. *Carpe diem!*

Sergeant First Class Timothy Dillard, a master diver, is a senior training developer at the Engineer School. He was previously assigned to the 502d Engineer Diving Detachment, Korea; the U.S. Army Diving Detachment, Fort Eustis, Virginia; and the Naval Diving and Salvage Training Center, Panama City, Florida.

Master Sergeant Peter Swenson is the senior coordinator for the 51 series career management field at the Engineer School. He previously served with the 34th Engineer Battalion (Combat Heavy), Fort Riley, Kansas; the 84th Engineer Battalion (Combat Heavy), Schofield Barracks, Hawaii; and the 802d Engineer Battalion, Korea. Master Sergeant Swenson is a graduate of the U.S. Army Sergeants Major Academy.

Soldiers interested in learning more about the Prequalification Course and the Naval Diving and Salvage Training Center can call the U.S. Army Diving Detachment, Fort Eustis, Virginia, at DSN 927-5658/5780 or commercial (804)- 878-5658/5780; or Sergeant First Class Timothy Dillard at Fort Leonard Wood, Missouri. DSN 676-7611/7502 or commercial (314) 563-4125.

NCO Proficiency: Bridge Demolition

By Sergeant First Class Gary D. Glover

An item in the August 1995 issue of *Engineer* (page 64) notes that the Career Management Field 12 Advanced NCO Course (ANCOC) at Fort Leonard Wood will no longer instruct bridge demolition in depth because that instruction is provided in the Basic NCO Course (BNCOC). Incoming ANCOC students are expected to be proficient in bridge demolition. Since records indicate that fewer than 3 percent of ANCOC students arrive with this knowledge, this article will address the knowledge gap. An article by Major Davis in the February 1993 issue of *Engineer* describes the history and basic concepts of the Sheffield bridge demolition method.

Bridge demolition is outlined in FM 5-250, *Explosives and Demolitions*, Chapter 4, Appendix A, pages A-10 through A-14 and Appendix H. Although the following discussion refers to FM 5-250, some entries in the manual are incorrect and do not correspond to the answers provided below.

Determine Bridge Category. This is the first step in determining the proper attack method and number of cuts needed to demolish a bridge. The flow charts on page 4-10 of FM 5-250 (for simply supported bridges) and page 4-15 (for continuous bridges) assist in selecting the appropriate attack method from those described in Appendix H. Read Chapter 4 thoroughly to understand the various bridge types and how to identify them. A simply supported concrete T-beam deck bridge with bottom support is used in the following examples.

Determine and Verify the Proper Attack Method. Using Appendix H, Table H-3, page H-3, you must first categorize the bridge to determine the appropriate attack method. Given a concrete T-beam deck bridge with bottom support, turn to page H-6. Serial 20 tells us that a top attack can be performed. Table H-3 also stipulates that "E is less than ER." As explained in Chapter 4, page 4-14, this note applies only to bottom attacks. End clearance (E) is a determining factor for bottom attacks but does not apply for top attacks.

Top Attack

A top attack, the quickest method of bridge demolition, is outlined on page A-13. This method should be used on all preliminary targets and when a bottom attack is not feasible. To perform a top attack, complete the following steps:

First, determine the amount of concrete that must be removed to create a successful hinge, using the bridge measurements on page A-10 and information on Table H-2, page H-2.

Note: *For arch and pinned footed bridges, use Table 4-1, page 4-20, instead of Table H-2.*

Determine the height-to-length ratio (H/L). The height of the bridge is determined by measuring the distance from the bottom of the beam to the top of the roadway. In this case H = 1.2 meters (m). The length (L) is the total length of the span. In this case L = 30 m. Divide the height of the bridge by the length of the span as shown:

$$\frac{H}{L} = \frac{1.2}{30} \qquad \frac{H}{L} = 0.04$$

Second, determine the average length of the bearing support (Ls). Add the lengths of the near- and far-shore bearing supports and divide the total by 2, as shown on page 4-13. For this example, use the measurements on page A-10:

$$L_S = \frac{L_S1 + L_S2}{2} \qquad L_S = \frac{1.0 + 0.8}{2} \qquad L_S = \frac{1.8}{2} \qquad L_S = 0.9$$

Next, determine the Ls-to-L ratio, using the formula of Ls/L:

$$\frac{L_S}{L} = \frac{0.9}{30} \qquad \frac{L_S}{L} = 0.03$$

Apply the values of H/L and Ls/L to Table H-2 to determine the length-of-cut-to-length ratio (Lc/L). Read Note 3 before applying the values to the table. In this example, both the H/L and the Ls/L values are on the chart exactly. The Lc/L value is the point where these values intersect. In this case Lc/L = 0.029.

Last, focus on the last sentence of Note 3. Multiply 0.029 (Lc/L) by 30 (L) to determine the actual length of cut (Lc).

Bottom Attack

Sometimes a bottom attack is needed, as for a reserved target where the roadway must stay open. The end clearance (E) is a primary factor in a bottom attack. Compare the actual end clearance (E) with the required end clearance (ER). Use the measurements shown in Annex A, page A-12 and Table H-1, page H-1.

First, determine the actual end clearance (E) of the bridge, which is the sum of the end clearances of the near and far shores. Using the formula on page 4-13 and the measurements on page A-12, we determine the actual end clearance is 0.4 m.

Next, determine the required end clearance (ER) needed to successfully drop the span. First, determine the height-to-length ratio (H/L):

$$\frac{H}{L} = \frac{2.1}{25} \qquad \frac{H}{L} = 0.084$$

Using Table H-1, page H-1, locate the H/L value (0.084) on the chart. Read the first part of Note 2. Since 0.084 is not on the chart, round that figure up to 0.09. Read the number directly below 0.09 to determine the required end-clearance-to-length ratio (ER/L) — 0.0160. Apply Note 3 to this value to determine the required end clearance (ER):

$$0.016 \times 25 = 0.4 \text{ m}$$

This is the minimum value of total end clearance, in meters, required for a successful attack. Because the actual end clearance (E) is 0.4 and the required end clearance is 0.4, a successful bottom attack can be performed.

A bottom attack can be performed even if the ER value is greater than E value. In that case, it is also necessary to destroy the near-side abutment.

Failure to properly determine the required end clearances for a bottom attack can result in a three-pinned arch (Figure 4-10, page 4-5). During a bottom attack, the bottom ends of the bridge initially move toward the abutments. Without sufficient end clearance, the bridge will jam at these points before the hinge has moved far enough to compensate for the movement.

Charge Calculations

Determine the amount of explosives required for bridge demolition by using the predetermined critical measurements in the concrete stripping charge formula:

$$P = 3.3(3.3h + 0.5)^3.$$

Appendix A, page A-10, shows the explosives calculation process. Using the measurements on page A-10, the procedure to determine the amount of explosives for the beams is—

Step 1: Determine the amount of explosives (TNT) required per meter:

$$P = 3.3[(3.3 \times 1.2) + 0.5]^3$$

$$P = 3.3(3.96 + 0.5)^3$$

$$P = 3.3(4.46 \times 4.46 \times 4.46)$$

$$P = 3.3(88.716536)$$

$$P = 292.76$$

Note: *During this step the sum of* 4.46^3 *is left in the calculator and is cut off only after the final step of multiplying by 3.3. The answer, 292.76456, is cut off at the hundredths place. In some situations it may be necessary to round the answer up to the next higher value of hundredths. Rounding may make a difference of 1 pound or 1 package of explosive.*

Step 2: Determine the amount of explosives (TNT) required per beam:

$$P = 292.76(0.35)$$

$$P = 102.466$$

Note: *At this point you can cut off at the hundredths place or round up from the thousandths place. Let's look at both scenarios.*

Cut Off	or	Rounded Up
$P = 102.46$		$P = 102.47$

Note: *If TNT is used for the demolition, round up the total pounds at this step. In both examples above, 103 pounds of TNT are required per beam.*

Now let's determine the amount of explosives required using C4.

Step 3: Determine the equivalent amount of C4:

Cut Off	or	Rounded Up
$\frac{P}{RE} = \frac{102.46}{1.34}$		$\frac{102.47}{1.34}$
$P = 76.46$		$P = 76.47$

Step 4: Determine the required packages of C4:

	Cut Off	or	Rounded Up
$N = \frac{\text{Charge weight}}{\text{Package weight}}$	$\frac{76.46}{1.25}$		$\frac{76.47}{1.25}$
	$N = 61.16$		$N = 61.176\ (61.18)$

A total of 62 packages of C4 is required per beam.

Use the same process to determine the amount of explosives needed to demolish each slab section of the bridge. When determining the amount of charge needed for each slab in a concrete T-beam deck bridge, you must consider the dimensions of the end slabs. If the sum of the width of the two end slabs equals the width of the internal slabs, the end slabs can be counted as one when determining the total explosives needed. If the sum of the width of the two end slabs differs from the width of the internal slabs, they must be calculated separately and added to the total explosives needed.

Determine the total explosives requirement. Multiply the number of beam charges by the required charge per beam to determine the amount of explosives needed to demolish the beams. Use the same process to determine the amount of explosives needed to destroy the slab sections. The sum of the beam explosives and the slab explosives equals the amount of explosives needed to destroy the bridge.

Explosives Placement. To assure a successful bridge demolition, the charges must be placed in appropriate positions. Annex A, page A-11, depicts a cross-sectional view of properly placed charges. Proper placement along the length of the span depends on the correct categorization of the bridge (simply supported or continuous) and the attack method (top, bottom or angled).

Note: *In previous bridge-demolition procedures, it was necessary to compare the ditch width (Wd) with the "Lc". Current research shows that this step is not necessary and has no impact on successful bridge demolition, providing all calculations are correct. Therefore, the ditch width information on page 4-8 and the calculations on page A-11 of FM 5-250 no longer apply to bridge demolition. (See manual change dated 12 January 1994.)*

Now test your knowledge of the Sheffield method of bridge demolition by completing the *Engineer Problem* on page 27.

* * *

This article and the following Engineer Problem/Solution were submitted by Sergeant First Class Gary D. Glover, an instructor/writer for CMF12 ANCOC at Fort Leonard Wood, Missouri. SFC Glover previously served in the 16th Engineer Battalion and the 66th, 567th, and 43rd Engineer Companies. He holds a bachelor's degree from Columbia College.

Engineer Problem

Situation: You have tasked a squad leader to perform a demolition reconnaissance mission on a bridge that is a preliminary target for demolition using C4. The squad leader's report provides the following information:

Bridge Type: Concrete slab, deck, with bottom support, simply supported.
Critical Dimensions:
  Span length (L) = 35 meters (m)
  Bridge height (h,H) = 1.1 m
  Bridge width = 6 m
  End clearances:
    Near shore (E1) = 0.2 m
    Far shore (E2) = 0.3 m
  Bearing supports:
    Near shore (Ls1) = 0.9 m
    Far shore (Ls2) = 0.8 m

Type of Attack: Top attack. A bottom attack can be performed if the friendly side abutment is also attacked.

Amount of Explosives: 62 packages of C4.

As the platoon sergeant, you must determine if the squad leader's calculations are correct based on the given critical dimensions.

Reference: FM 5-250.

Engineer Solution is on page 42.

Letter To The Editor

I read with interest the article by Jeb Stewart ("Thinking Through Force XXI," *Engineer*, August 1995, p. 19). His personal views posed some engaging points. Of interest to me were his concerns about "...the absolute reliance on computer software." Mr. Stewart states that all of us who work with computers have been the victims of poorly designed or poorly adapted software. He witnessed what he called "overstressed computer networks shutting down under the workload." There probably is more truth than fiction to his assertions. Although he provided no facts related to his resentment of automation, especially computer software, I understood his point.

My response is to look at the everyday conveniences we now take for granted. Today, all cars and trucks are built, tested, and repaired with computers and software. The venerable television is a digital colleague of the personal computer, camcorder, VCR, and electronic games. Home appliances have sophisticated integrated circuitry developed with the aid of computer software. Have you seen the educational software available to students? Do you have a cellular phone? The telephone systems in most cities consist of computer-controlling digital connections. Don't forget the Gulf War: It was as much a war about technology as it was anything else. Millions of people watched in astonishment as CNN televised live the impact and incredible accuracy of software-controlled, laser-guided smart bombs and missiles that found their way to Iraqi targets.

It's true that there have been many problems and many naysayers who did not believe in the changing technology. Mr. Stewart is not alone in this regard, and no doubt many mistakes have been made (and will continue to be made) by systems and software developers. It's still called progress even when we fail. But I venture to guess that most mistakes were the result of human errors not software errors. My point is that we cannot stop progress because we don't have a perfect solution or because it causes some inconveniences.

Michael J. Killoren, Assistant to the Garrison Commander, Fort Leonard Wood.

Letters to the editor are welcome. Address them to: Editor, Engineer Professional Bulletin, *ATTN: ATSE-TD-D-EB, Fort Leonard Wood, Missouri 65473-6650.*

Design at Your Fingertips:

The Theater Construction Management System

By Sergeant First Class Tony R. Arnold and Fred Steinman

Attention all combat heavy engineer battalions and above. Life in theater of operations construction will soon be much easier with designs at your fingertips.

In 1990, the U.S. Army Corps of Engineers began a study to update the Army Facilities Component Systems (AFCS), used by major commands as the principal source for standardized construction in theaters of operation. Maintained by the Huntsville, Alabama, Division of the Corps of Engineers, this system used information published in Technical Manuals 5-301, *Planning;* 5-302, *Design;* and 5-303, *Logistics Data and Bills of Material.* The system was too costly to maintain, with changes to existing drawings requiring many hours of drafting in addition to increasing reproduction expenses and problems in product distribution.

Objectives of the AFCS update were to decrease the time engineers spend planning and designing projects and to improve their ability to manage theater construction. With this in mind, the Construction Engineering Research Laboratory developed a computer database system to store the AFCS drawings. The result is the Theater Construction Management System (TCMS), now the approved source for standard designs, bills of material, construction time estimates, and planning information for facilities constructed by Army engineers in OCONUS and in theaters of operation.

The Corps of Engineers began distributing 260 copies of TCMS version 1.2 in the second quarter of FY95 and will complete distribution in FY96. Units receive a 230-megabyte external hard drive with off-the-shelf software: Microsoft Projects version 4.0, AutoCad LT version 1.0, Close-up version 6.0, and the government-developed TCMS software and AFCS databases. The hardware that units must provide to run the system and its software are shown in the table on page 29. Improvements and additional designs to the system will be fielded annually.

The Engineer School has 30 systems in place and will receive 22 more during FY96. The school curriculum has included portions of the TCMS since April 1994. The 51T10 course includes computer-aided drafting and design (CADD) and Terra Model software for surveying. Project management using Microsoft Projects 4.0 is trained in the Engineer Officers Basic and Advanced Courses. The 51T30 course includes training in CADD, project management, Terra Model, and files management for CADD. The automated training for the 51T30 Basic Noncommissioned Officer Course, which will focus on the use and management of TCMS, is scheduled to begin in FY96. As the systems and hardware become available, the Engineer School will incorporate more TCMS training in all courses.

With TCMS, engineer units can access the AFCS drawings and databases to speed up the planning and design phases of all theater construction. Since the user produces only the drawings needed for his project, reproduction costs are reduced 40 percent or more. In addition to drawings and databases, the system combines government-developed and commercial software to provide the capability to plan, design, and manage all unit construction missions.

Beginning in 1994, the AFCS program was expanded to include standard designs for facilities constructed by Army engineer units in support of nation-assistance programs. Army engineer construction units embark annually on OCONUS missions to construct schools, dispensaries, roads, bridges, wells, and other basic community projects. The engineer activities

Unit-Supplied Equipment for TCMS

Hardware	Recommended Configuration
Microprocessor	80486
Hard disc drive	120 MB or larger
Math coprocessor	Required
RAM	16 MB or larger
Monitor	Super VGA, 16- to 19-inch
Mouse	2-Button
Printer	Laser (dot matrix will work)
Plotter	16-Pin
Modem	Optional, to receive updates in the future
CD ROM	Optional medium for future updates

required for these missions include planning, logistics, design, management, and construction. Before 1994, each unit accomplished these tasks independently, often without the benefit of past experience or standard designs (see sidebar). With the expanded mission of the AFCS program and the cooperation of involved Army units, a family of standard nation-assistance designs will be available through TCMS.

Units are encouraged to send their design drawings through their major command to the Huntsville Division of the Corps of Engineers so they can be added to the system. The ongoing effort to include standard designs depends on cooperation between the Huntsville Division, the U.S. Army Southern Command (USARSO), and the Active, Reserve, and National Guard units involved in theater construction in South and Central America. Other theaters will be handled in the same manner.

The cycle of incorporating and refining designs will expedite future construction missions and enhance the sharing of lessons learned. It's time to stop recreating the wheel and start it evolving into the engineer force of the 21st century.

Sergeant First Class Arnold is the senior training developer for 51T, Directorate of Training and Doctrine, U.S. Army Engineer School.

Mr. Steinman has worked in the Army Facilities Components System Program, Huntsville, Alabama, for 17 years and was instrumental in its design modernization. A Navy veteran from the Korean War Era, he is a certified professional logistician and a member of the Society of Logistics Engineers.

For more information about TCMS and system requirements call SFC Tony Arnold at (314) 563-4115 or DSN 676-7593. Questions may also be addressed to Fred Steinman or Sandra Mayes, Huntsville Division of the Corps of Engineers, at (205) 895-1783/1784.

Engineers Build a School in Belize

By First Lieutenant Barry Wilson

Standardization is an important principle for the U.S. Army. Everything from a passing score on a physical fitness test to the number of bolts required to secure a Bailey bridge is standardized. Its importance was further emphasized to the South Carolina Army National Guard's 122d Engineer Battalion in January 1995 when we were tasked to build a primary school in Double Head Cabbage, Belize. The 122d designed the project, developed the construction plan, and determined the bill of materials. This process is nothing to raise the eyebrows of an engineer because that's what we do. However, the 122d had built a similar school in Pedasi, Panama, in 1994; but since we did not have access to the new TCMS database containing this plan, the unit's architect had to design the Belize school from scratch.

After successfully completing the 1995 mission in Belize, we submitted the school design through the U.S. Army Southern Command (USARSO) to the Huntsville Division of the Corps of Engineers. Now part of the TCMS, these design drawings, the bill of materials, and the construction plans are available to other units with similar missions.

As units submit drawings, USARSO will collect a variety of school designs for their customers to choose from, which will allow for nation-specific modifications. For example,

Top photo: **The old school in Double Head Cabbage, Belize, was overcrowded and poorly constructed.**

Bottom photo: **Members of the 122d Engineer Battalion and children of Double Head Cabbage stand beside the new school.**

Panamanians prefer block-designed school windows, while the Belizeans like windows with louvers that provide protection from the weather.

Standardized plans not only save time, they also allow better quality control. Each plan has a built-in waste factor that may vary from nation to nation. The 122d found that in Panama there is a 20 percent waste factor because of the cinder block quality. When the same percentage was used to order blocks in Belize, where their quality is better, we ordered too many blocks and wasted project funds.

Standardized plans should indicate the amount of equipment to be drawn from the home station and from the main support area for theater equipment. This capability will improve coordination between the tasked unit and USARSO. It will also allow better programming for the limited air, sea, and land assets needed to transport equipment to the area of operations.

Data from previous exercises also will help the Army Contracting Office choose vendors that work well with the military in each country. With a standardized bill of materials, the contractor can shop for the best price instead of settling for an overpriced "bargain."

Standardized plans with realistic start and completion dates will take the guesswork out of construction projects by allotting the correct amount of time, manpower, supplies, and equipment. Plans should also show the type of work to be performed in certain weather and climates—for instance, scheduling new construction in the dry season and renovations in the wet season.

Standardization is an important concept for the Army because it saves time and money and eliminates waste. Standardized project plans are no exception. Engineer units are encouraged to cooperate with USARSO's effort to expand the TCMS so we can continue to complete our missions economically in an era of shrinking budgets.

First Lieutenant Wilson is the S2 for the 122d Engineer Battalion. He previously served as the assistant S2 for the 4/118 Infantry Battalion at Union, South Carolina.

Active Engagement:

Charting a Career Path

By Major James B. Balocki

Force XXI, E-Force, 10-division Army, downsizing, base realignment and closures... Today's rapidly evolving military force structure demands that every engineer officer be actively engaged in charting a career path. Selecting the right job after company command is difficult and getting more so by the day. Whatever you decide probably will take you away from troops. Among the potential assignments is duty with a U. S. Army Corps of Engineers (USACE) district. These assignments offer challenging work, professional experience, and excellent preparation for future duty assignments, but most engineer officers are not exposed to this part of our unique organization before being assigned there.

This article introduces company grade officers to the Civil Works and Military Construction districts and the engineer officer's role in their national and military infrastructure support missions. It is based on one soldier's experiences. Anyone considering a USACE tour should seek additional information from friends, mentors, or other senior officers.

Regardless of the path engineer officers follow to arrive there, they bring valuable qualities to a USACE district: organizational leadership skills, problem-solving abilities, a sense of mission, and a desire to work with people. Company grade officers are assigned to a district to broaden their leadership experience and understanding of the organization. These assignments expose them to the full spectrum of missions accomplished by the Corps of Engineers and prepare them for future senior leadership roles.

Preparation and Education

If you attend graduate school, design a training plan to enhance and complement your leadership skills. Courses in these subject areas will prepare you for duty in a USACE district:

Negotiations. Nearly everything you do in a district, whether working with contractors or staff team members, requires negotiations. This course is typically found in the school of business.

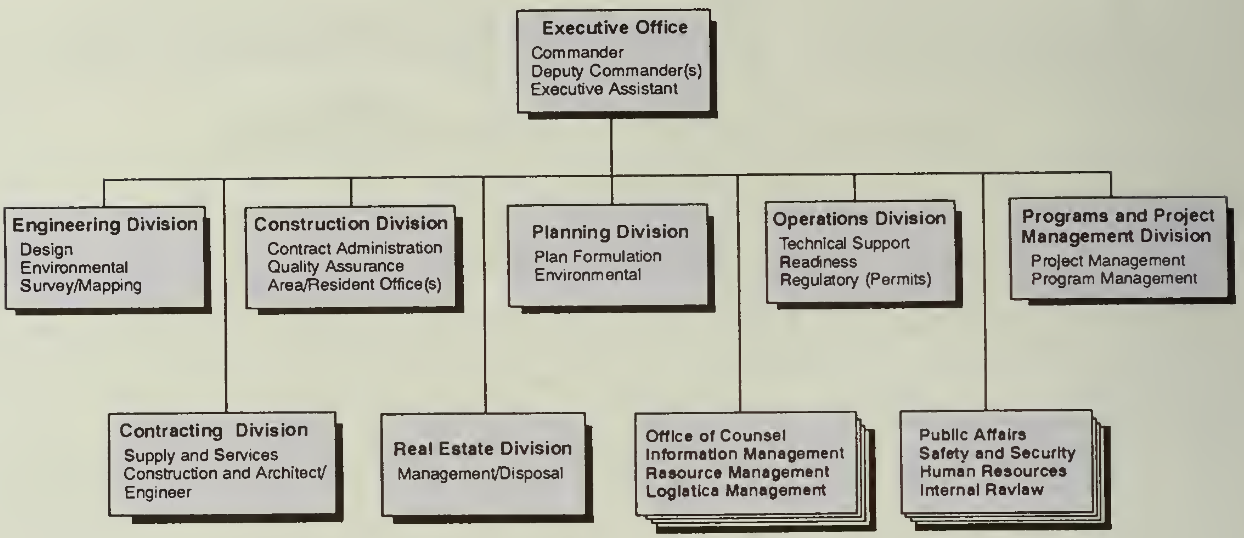
Construction Contract Law. It's essential to have a solid foundation in the principles of construction law. This course introduces the government contracting process in a district, where you may manage multimillion-dollar contracts.

Construction Management. This is the heart of many military officers' duties in a district. Courses in project management and network analysis will serve you well. Work them into your training plan.

Environmental Engineering, Hydraulics, and Hydrology. Corps projects depend on

Understanding technical products is essential to effectively administer construction contracts, which are at the heart of a military officer's duties in a district.

U.S. Army Corps of Engineers District



Organizational structure of a typical U.S. Army Engineer District.

expertise in these areas, so become familiar with their fundamentals and language.

Soils. Gain an understanding of the basics of soil mechanics, stabilization, and failure mechanisms.

Other. One important course to complete before joining the district is "Management of Defense Acquisition Contracts (Basic)," offered by correspondence from the Army Logistics Management College. This introduction to government contracting will help decode many common acronyms.

The Corps' Huntsville Division offers "Civilian Personnel Management for Key Military Leaders" in residence. This essential course provides insight into the career development and management of civilian employees.

Once on duty, the Corps offers numerous professional development courses. Engineer Regulations 350-3-5 and 350-7-1(FR) itemize courses required for military officers in district assignments. HNDP 350-1-1, known as "The Purple Book," contains a comprehensive catalog of all courses. Subjects range from finite element analysis to financial accounting systems.

Early in the tour, take time to learn how the authorization and appropriation processes work. Money is "painted different colors." Some funds must be used in the fiscal year Congress appropriates them, others expire after longer periods, and some don't ever lapse. This area is as confusing for seasoned Corps veterans as it is for rookies, but a good foundation will help avoid pitfalls.

Organization and Environment

The Corps is organized hierarchically. The figure above shows a typical (generic) district wiring diagram. Each district is structured to support and accomplish its primary mission and generally has the same functional divisions and offices, although some roles may be combined. For example, the construction and operations functions may be autonomous divisions in one district but be under one roof in another.

Like a brigade, each district is subordinate to a division, typically commanded by a general officer. The division reports to Headquarters, U.S. Army Corps of Engineers, commanded by the Chief of Engineers.

Each USACE district's culture is unique and process-oriented. Laws, regulations, and individual personalities affect the decision making process in a district much more than in a troop unit. Because the "just do it" attitude can sometimes lead to disaster, recommendations usually are staffed and team consensus built before a decision is implemented.

Consider, for example, a seemingly simple change to a construction contract—adding an interior door. This idea might be initiated at a construction site for an office building. It will be reviewed by an engineer to ensure that the door's placement and construction conform with fire-protection codes, and a contract specialist will ensure that the change is within the scope of the original project. Next a cost estimator will assemble a government estimate to use in negotiating the change. The resource manager will review the estimate to ensure that sufficient and correct funds are available. After that, a contracting officer's representative will negotiate with the contractor to agree on the cost

Engineer officers in a district assignment often participate in disaster recovery operations as part of a Corps team. Responses to floods, earthquakes, or hurricanes present unique problem-solving and leadership challenges in an adverse environment.

and time needed to complete the change. Then a contract modification will be prepared, signed, and delivered to the contractor. Finally, you get a door! The process can be slow and frustrating at times, but staff skills acquired in a troop unit will prove valuable in accomplishing the mission.

District-division-headquarters staff chains also work differently than the chain in a troop unit because of the nature of each functional staff's mission and the long-term tenure of the dedicated civilian work force. This chain is often called a functional "stovepipe." Many tasks and much information are passed through these staff stovepipes, outside of the command channel. The stovepipes exert a strong influence on civilian career ladders, and people tend to be responsive to functional counterparts at higher command levels.

The Corps has worked hard to break out of the traditional hierarchical stovepipe paradigm. By introducing project management into the district structure and culture, they focus attention and resources on successful completion and delivery of projects to customers. Project management involves assembling a tailored team from among the technical disciplines. The integrated team, led by a project manager, is responsible for ushering a project from inception through delivery and beyond—from cradle to grave.

To learn more about the organization, talk to the people who work there. Learn what they do and how they perform their jobs. Find out how their jobs fit into the district's mission and why they are important. Observe, learn, and ask a lot of questions. When someone uses an acronym you don't understand (and there are plenty), ask what it means. Chances are you'll encounter it again. Listen to "war" stories; they embody information about how the Corps works, what it does, and most importantly, the inner workings of the district—how things get done.

The Corps Team

The Corps is staffed with dedicated professionals and leaders, managers and technical team members. Military officers fit into this team. However, they may have to prove their worth to the team before they are given a choice assignment. Engineer officers enter USACE district service with a solid reputation as hard-working, intelligent leaders. District staff members have high expectations of them but understand that the officers lack experience and exposure to the system.

Company grade officers may encounter different attitudes toward military officers serving in the district. Career civilian employees may label them "just passing through" because of their relatively short tenure. Because the job they fill may be a growth or developmental position for their career civilian counterparts, military officers may be viewed as restricting a civilian's career growth. Another tag they may inherit is "the colonel's spy." Military officers have a unique association and access to their commander, which many civilians feel they don't share. These labels may be a source of cloaked resentment. You can't avoid them; simply be aware they exist and work hard to become a member of the district's team.

Leadership is the most valuable asset military officers bring to a USACE district assignment. The setting offers company grade engineers an opportunity to lead in an unfamiliar environment, which requires different leadership skills than those used with troops. Missions are assigned and tasks accomplished in an atmosphere of cooperation. Situational leadership skills are essential whether you're dealing with contractors who are behind schedule or quality assurance representatives who are inspecting the project. The Corps has many fine leaders, but you bring a unique perspective to the district.

Some USACE district assignments involve Military Construction or Civil Works projects. The Military Construction program supports infrastructure development and maintenance for the Army, the Air Force, and others. Hospitals and troop barracks construction, facilities rehabilitation, and hazardous-waste-site cleanup are among the many Military Construction missions. The Civil Works program is equally diverse but focuses on improving and maintaining the nation's rivers and harbors. Hydroelectric dam improvements, navigation lock construction, harbor dredging, and flood control are among the many Civil Works challenges.

One emerging area, the Work for Others program, is growing rapidly. It puts our skills as the nation's premier engineering organization to work for federal agencies outside the Department of Defense. Some projects are similar to traditional Corps roles, while others are unique, leading-edge engineering endeavors. The Environmental Protection Agency, the Department of Energy, the Department of Agriculture, and other federal agencies are among a growing list of customers with diverse missions supported by the Corps. Regardless of where you end up, the work will be stimulating, intellectually challenging, and professionally demanding.

Performance

When beginning a USACE assignment, plan on spending time in at least two positions: the district headquarters and the field—at a project, resident, or area office. Keep in mind that every job should broaden your leadership skills, help prepare you to become a district engineer or a deputy district engineer, and enhance your value to the Army.

Be aware that the duties of a company grade officer within a district are probably not well understood by many who serve on selection boards. The jobs you are likely to hold are not universally recognized as "key positions" and do not possess inherent career-enhancing benefits. This makes your performance extremely critical.

It is important to communicate the level of your responsibility and the challenges of your duties in a district by writing a clear position description. This point cannot be overemphasized. The key to board recognition of your job is an accurate duty description in terms that are widely understood in the Army.

Benefits

USACE district assignments offer opportunities to invest time in professional, personal, and family development. The demands of duty and the daily schedule normally do not require the same personal sacrifices as duty with troops. Manage time wisely. Set yourself apart by working intelligently, accomplishing each task professionally, and showing enthusiasm.

Continue professional development by enrolling in and completing the Command and General Staff Officer's Course by correspondence. If selected to attend the resident course, much of the material will be review, or you may opt to attend a sister service school. Either way, you will be ahead.

Spend time with your family. It is easy to become so involved in a project that your home life is sacrificed.

USACE district assignments offer many opportunities to establish new professional contacts. Most districts have strong affiliations with organizations that offer a wide range of opportunities for professional growth through association with civilian counterparts and professional societies. These beneficial relationships can lead to long-term associations that increase the overall professionalism of the Corps and enhance your qualifications.

Engineers are constantly confronted with challenges—a changing force structure and a continuing need to achieve individual and career goals. These challenges mandate that we actively plan and manage our careers. A variety of interesting and demanding assignments are available after you've completed company command and leave a troop unit. You'll find that a USACE district provides challenging duty, personal satisfaction, and tremendous professional opportunities.

Major Balocki is attending the Command and General Staff College, Fort Leavenworth, Kansas. He recently completed a second USACE tour, serving as deputy district engineer for the Walla Walla, Washington, District. He previously served with the United Nations and U.S. Joint Task Force-Somalia.

Engineer Battle Tracking

By Captain Kenneth J. Crawford and Major James E. Brooks

Through wars and engagements, command and control elements must continually maintain their focus on the combat power and capabilities of subordinate elements. This focus is critical for those involved with both deliberate and combat decision-making processes. The commander and his planning staff require immediate access to the critical information they need to make informed decisions affecting the lives of subordinates and the success of their missions. Through World War II, Korea, Vietnam, and Operation Desert Storm, staff planners and commanders often reinvented the wheel for tracking battles in their tactical operations centers and command posts because no standard reporting process existed. Today units need complementary tracking systems that are applicable to the various task organizations in the combined arms environment. This article describes select elements of engineer support to a combined arms task force and presents some standard, complementary charts staffs and leaders can use to track those elements.

Historical Reference: *General George Patton successfully launched a "reconnaissance-in-force" and seized Palermo on 22 July 1943. Given his staff's ability to maintain a vigilant perspective on the combat power of his two (+) divisions, Patton changed a defensive mission to an attack on Palermo with a great deal of success.*

Elements of Engineer Support

We cannot standardize the precise information engineers need to report because requirements vary by theater and mission. Maneuver support, reports, and data for engineer requirements apply across a broad spectrum, with little change in how to sort and post information related to each operation. However, engineer support for maneuver forces conducting peacekeeping operations, low-intensity conflicts, and training exercises have one thing in common—the decision-making process. Engineers use battle tracking as a tool to provide timely, doctrinally based information to maneuver commanders as they implement the tactical decision-making process. The tracking system must be simple to maintain and easy to reference. First, we will discuss how we sort information and apply doctrinally correct and timely information to battle tracking.

Flow of Information

The commander's critical information requirements drive the staff's focus for battle tracking. Information flow is a two-way network. Subordinate elements, the eyes and ears on the battlefield, provide timely *ground truth* to leaders for dissemination as required in situation reports, scatterable mine warnings (SCATMINWARNs) and size, activity, location, unit, time, and equipment (SALUTE) reports. Higher headquarters provide subordinate elements with directives and information through operation orders (OPORDs), fragmentary orders (FRAGOs), and warning orders (WARNORDs), which have clear tasks and purposes.

Timeliness of Information

Disciplined units thrive on accurate and complete information disseminated both up and down the chain of command. Success prevails when commanders make decisions based on current information, while decisions made with outdated information often lead to disaster. Commanders at all levels also rely on the information reported to be useful. The old adage "garbage in—garbage out" will not apply if engineers ask the right questions and clearly and concisely report essential data. For example, reconnaissance elements must be given specific tasks that support current and future tactical information requirements so that the staff can track reports received on standard charts. Engineers must ensure that the information they receive and provide is relevant to each special staff's needs for operational planning and execution (intelligence, operations, logistics, transportation, and maintenance). If each staff element generates additional requirements based on its needs, subordinates may get caught in the research of outdated or superfluous data. Bottom line: ensure that the information you provide is relevant to the situation and don't create undue reporting requirements for others.

Doctrinal Information

Tactical and operational input must have a doctrinal base as an initial reference. Engineers use doctrinally based battle-tracking charts to refine the information required for a mission. The charts below are designed to provide each staff position and user with compatible and doctrinally based information.

The commander decides how to successfully attain the advantage over the enemy with minimal losses to his troops and equipment. To facilitate those decisions, the staff provides the commander with brief updates regarding his combat power capabilities. Combat power has four primary elements: maneuver, firepower, protection, and leadership (FM 100-5, Chapter 2). For engineers, the definition of combat power differs by unit based on its capabilities and support roles.

Maneuver is the movement of combat forces to gain positional advantage. Mobility and countermobility are the engineers' implied support tasks. Mobility includes the unit's capability to successfully breach obstacles (friendly and enemy) as part of the attacking or movement-to-contact force. To clear and maintain lines of communication (LOC), engineers must perform several mobility, sustainment, and force-protection tasks. They perform countermobility tasks when reinforcing terrain to disrupt, turn, fix, or block an enemy force.

Firepower is the destructive force determined by the amount of fire delivered by a unit, position, or weapon system. As combat multipliers, engineers provide countermobility and survivability support to maneuver forces. By integrating obstacles with firepower, engineers maximize the standoff and probability of kill to the friendly units' advantage. To maximize the unit's ability to survive and fight, they provide equipment to develop and improve individual and vehicle fighting positions and unit battle positions. Engineer "firepower" is their ability to shape the battlefield by tying in natural and manmade obstacles. The primary weapons systems or platforms used to accomplish those tasks are the Volcano, MOPMS, conventionally placed mines, and digging assets.

Protection is the conservation of the fighting force. Engineers provide sappers to gather obstacle intelligence (OBSINTEL), conduct covert breaches, and support deep interdiction. Blade assets provide increased survivability and protection to maneuver and support forces. Properly integrated survivability and force-protection efforts can significantly increase the maneuver forces' success when they are applied against defending, withdrawing, or even attacking forces. When engineers provide higher headquarters with timely, accurate, friendly and enemy obstacle data, they increase the commander's overall situational awareness and decrease the number of potential fratricides.

Leadership drives the competence and courage of a unit's soldiers. Unit commanders and leaders must know where their presence can make the greatest impact on the morale, motivation, and success of their soldiers. To the engineer, leadership represents the backbone of mobility and countermobility support tasks. It is not merely the presence of leaders, but the presence of qualified and trained leaders who successfully support maneuver forces.

Flow of Missions

Missions are generated either as proactive or reactive measures. For example, staffs are proactive when they generate OPLANs as missions to be executed at a prescribed time or when specific conditions occur. OPORDs often are reactive because they prescribe orders based on current intelligence, actions taken, or missions generated from either higher or subordinate headquarter's requirements. OPLANs take units to the initial encounter, where they expand through branches and sequels to the operation. Proactive planning provides the commander with the flexibility to execute battlefield missions based on his assumed or projected combat power and capabilities. The execution phase changes as a result of reconnaissance; loss of combat power; and discovered or identified obstacle locations, disposition, type and quantity. By tracking this critical information, engineer planners and commanders maintain the tools they need to plan for changes in mobility support. Units disseminate FRAGOs and OPORDs to subordinate elements so they can develop supporting tasks to meet the tenets of Army operations (agility, initiative, depth, synchronization, and versatility). Information received by supported or supporting units may affect routes, force array, or equipment limitations/capabilities.

Basic Battle-Tracking Charts

Until a doctrinally based battle-tracking system is developed, engineers can use the following charts to provide complementary information that supports the maneuver commanders' decision-making processes in any theater of operation.

Task Organization and Combat Power

These charts are cross-referenced to back-up data or supporting quick-reference charts to reflect significant deficiencies in combat power and capabilities. Units must develop and rehearse command post battle drills using flow charts and manage the data they receive and provide for mission planning and execution. Mission requirements may alter staff or commander decisions based on the unit's ability to support a specific task. Whether the data provided are subjective or objective, users can cross-reference them against supporting battle-tracking charts to develop a planning tool that supports the commander's decision-making process.

Combat Power

As of: ____________________

	Unit	Task Org	Location	Personnel/Leadership		Maneuver	Firepower	Protection	Cdr's Eval
				Authorized	On Hand				
⊕									
⊕									
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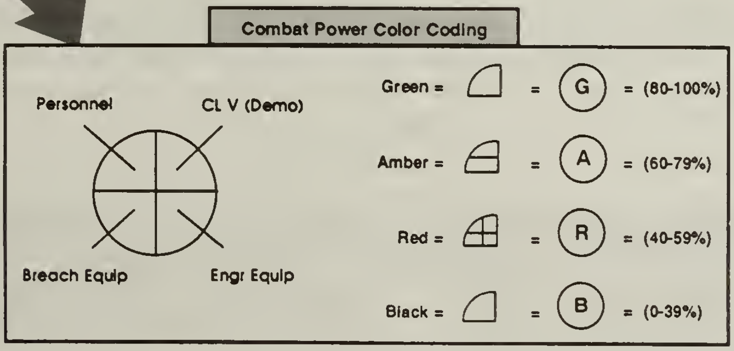
For Example

	Unit	Task Org	Location	Personnel/Leadership		Mobility	Counter-Mobility	Survivability	Cdr's Eval
				Authorized	On Hand				
⊕	C/27	DS - 3/82	WE 037401	5/1/117	5/0/108	Ⓖ	Ⓖ	Ⓐ	Ⓖ
⊕	B/307	ATCH - 2/82	WE 036429	5/0/89	4/0/78	Ⓐ	Ⓐ	Ⓖ	Ⓐ
⊕	A/326	ATCH - 1/101	WE 018443	5/0/89	5/28/63	Ⓖ	Ⓖ	Ⓐ	Ⓖ
⊕	1/C/41	DS - 1-87/10	WE 060415	1/0/26	1/0/24	Ⓖ	Ⓐ	Ⓐ	Ⓖ

Combat Power Color Coding



Service Support

Users need quick-reference charts that show critical engineer classes of supply that may affect current or future operations. Both the engineer and the S4/logistician must closely monitor these data. Subordinate elements must be accountable for the receipt and expenditure of resources affecting future operational planning, forecasting, and cross-leveling.

Service Support

As of: ____________________

	Unit	Concertina	Wire	AT Mines	AP Mines	NE Caps	C4	MICLIC	APOBS	MOPMS
Ⓖ	C/27	360/350	52/50	520/500	127/100	84/75	190/184	2/2	5/5	2/2
Ⓖ	B/307	300/300	46/45	813/800	107/100					
Ⓐ	A/326	280/350	41/60							
Ⓐ	1/C/41	120/150								

(Required/On Hand)

Critical Engineer Equipment

The maneuver force's primary means of mobility (ACE, CEV, AVLB, MICLIC), countermobility (Volcano, MOPMS, ADAM/RAAM), survivability and force protection (digging assets), and engineer forces' mobility (M113, dump trucks, HMMWV) are critical systems to track. When planning and executing missions, commanders and staffs need the capability to quickly update the number, condition, and location of these assets.

Critical Engineer Equipment

As of: ____________________

	Unit	Volcano	MICLIC	M998	M929A2	M916A2	M870	Scoop Loader	SEE	D5
Ⓖ	C/27	2/2	2/2	5/5	8/8	5/5	5/5	3/3	6/6	5/5
Ⓖ	B/307	1/1	0/0	13/13	2/2				6/6	
Ⓐ	A/326	2/2	1/2	14/15						
Ⓐ	1/C/41	0/2								

(Operational/On Hand)

Minefield Tracking

Friendly. To expedite the reporting and tracking of minefields, subordinate elements provide friendly minefield information via FM radio or multiple subscriber equipment and follow up with copies of DA Forms 1355 or 1355-1-R. Data for zones, belts, groups, intent, executing element, status, etc., are taken from initial entries on minefield records. The hard-copy records are used to verify data received and changes disseminated by the staff engineer and the maneuver S3.

Friendly Obstacles

As of: ____________________

	Lay Unit	Zone/Belt/ Group	Type and Number	Status	Start DTG	Comp DTG	Fr Grid(s)	To Grid(s)	Rpt Rcv'd	Remarks
Ⓐ	2/C/27	I082C3D	MT05	75%	080330Sep		WE123456	WE124458	Initiation	
Ⓖ	1/B/307	I082B1E	BS02	100%	081600Sep	082315Sep	WE023556	WE023556	Completion	(+) Armed
Ⓡ	3/A/326	I101C3D	RM09	50%	081330Sep		WE456789	WE456789		RC 100%
Ⓑ										

Enemy. This information, in conjunction with the S2's reconnaissance plan, drives route clearance, mobility planning, and reconnaissance missions. The sample minefield report on page B-3 of FM 20-32, *Mine/Countermine Operations*, can be revised to this format for battle-tracking purposes. Lines A (map sheets) and H (estimated material and equipment to clear) are omitted because those data should be decided by the executing unit.

Enemy Minefields

As of: ______________________

	Unit	Info DTG	Type MF	Grid(s)	Depth	Marked	Reduced	Cleared	Lane Grids
Ⓖ	1/1/C/27	081705Sep	(B) TM62	WE 123456	60 m	L/R Handrail	081735Sep	082013Sep	N/A
Ⓐ	3/2/B/307	090035Sep	(S/B) YAM5	WE234567	120 m	L Handrail	090215Sep		
Ⓡ	2/3/A/326	090835Sep	(S) TMBD	WE345678	40 m				
Ⓑ	2/1/C/41	100127Sep							

Situational Obstacles

A similar chart is used for situational obstacles. Engineers extract basic data from Chapter 7, Figures 7-5a through 7-9, FM 20-32, apply them to the supported situation, and disseminate critical information to the maneuver force.

FASCAM

As of: ______________________

	Lay Unit	Tgt/Obs #	System	Mine Type(s)	Start DTG	Life Cycle	Fr/To Grid(s)	Safe Zone	Rpt Rcv'd	SCATMIN-WARN
Ⓖ	1/C/27	1082A1TSV01	Volcano	AT/AP	080330Sep	48 hr (long)	WE123456- WE129455	235 m	Completion	080300Sep
Ⓖ	3/B/307	1082B4QSM22	MOPMS	AT/AP	072300Sep	4 hr (short)	WE023556	235 m	Completion	072230Sep
Ⓖ	2/A/326	108217MSW13	WAM	AT(75m)	080030Sep	12 hr	WE456789	200 m	Completion	072355Sep

Mission Status

This chart focuses on all aspects of missions generated or received. It provides the commander or user with a mission-status summary that enables him to quickly track current operations and plan future operations.

Mission Status

As of: ______________________

	Number	Mission	Type	Resp Unit	Location	Start DTG	Status	Comp DTG	Secure By	Remarks
Ⓐ	C4203	Road Repair	Crater	C/27	WE125456	081500Sep	75%		D/1-325	
Ⓖ	B128	Clear Minefield	AP	1/B/307	WE1334418	090015Sep	100%	090415Sep	A/1-325	
Ⓖ	A300	Destroy Cache	CL V	3/A/326	WE234567	080830Sep	100%			
Ⓑ	C101	Clear Route	Hasty							

Route/LOC Status

Reconnaissance elements or units report route and LOC trafficability data to their supported headquarters. Depending on the route's intended use and the accuracy of information reported, these data may generate route clearance, mobility, or repair missions for engineers.

Route Status

As of: ______________________

	Route	Fr Grid	To Grid	Surface	Status	Repair Req'd	Start DTG	Comp DTG	Secure By	Remarks
Ⓖ	RED	WE123456	VE876543	crsh gravel		rain erosion	082330Sep	100810Sep	D/1-325 Inf	
Ⓑ	WHITE	WE234567	VE889722	sandy loam	impassable	landslide	090800Sep	091500Sep	B/1-325 Inf	
Ⓡ	BLUE	WE123456	VE998490	asphalt	sev restric.	bridge out	090500Sep			fordable
Ⓑ	TEXAS	WE123456								

Summary

This article provides some doctrinally based battle-tracking charts that commanders and staffs can modify to fit their experience, requirements, and METT-T. While doctrine provides report formats to aid in the currency of reported information, the Army lacks standard, basic charts to track this information. Given a doctrinally based tracking document and the necessity to maintain and report timely information, the potential application of these charts is limitless.

Engineer leaders must focus on applying and maintaining the information they provide to maneuver force commanders and staffs, who rely heavily on timely and accurate information that supports their decision-making processes. In today's fluid environment, the Army executes a myriad of missions with nonhabitual task organizations around the globe. Based on the tactical situation, information flow within units and the Engineer Corps must be compatible to ease the transition to mission execution and battle tracking for maneuver commanders and staff officers.

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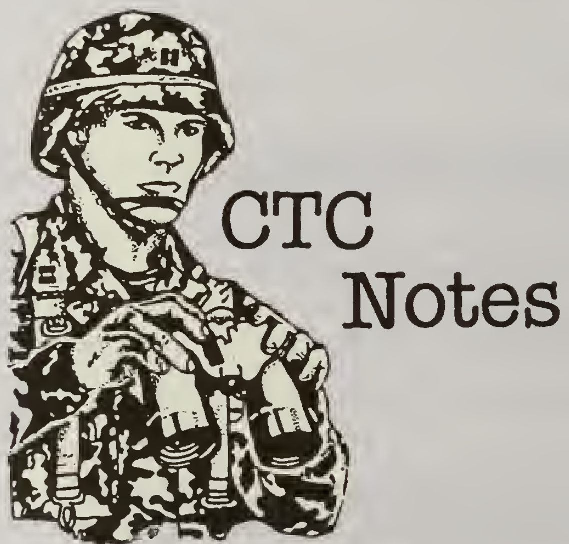


Battle Command Training Program

By Lieutenant Colonel Greg Stanley

Engineer Brigade Tactical Operations Center (TOC) Operations

Many engineer brigades struggle with the setup and operation of the brigade TOC. The following tactics, tips and procedures will help the TOC run smoothly:

1. Use flat maps to track the current situation and vertical (hanging) maps to display plans and template enemy activity. Flat maps are preferred for current needs because more people can work around them. They provide good visibility during briefings and allow several soldiers good views without having to look over the shoulders of others. Additionally, both the S2 and the S3 can track ground truth on the same flat map.

2. Separate the plans area from the current operations area. The plans area can double as a briefing area for issuing orders or meeting with subordinate units. Integrate staff sections in the operations area rather than separate the cells by function. Both the S1 and the S4 must know what is happening in the current operation.

3. Use information displays within the TOC to provide commanders and key personnel with a quick update without the need for numerous questions. Determine what information is critical to the commander and then track and display that information with charts. Avoid too many charts.

Key engineer information is determined by the commander. It normally includes—

- Task organization.
- Elements of the engineer commander's situation report (engineer equipment, personnel, and the commander's assessment).
- Status of Class IV and Class V materiel.
- Main supply routes.
- Current engineer missions.
- Commander's critical information requirements.

4. Place desks for the commander and the executive officer (XO) in the center of the action where they can see, hear, and supervise all activity. Radios, phones, and radio-telephone operators (RTOs) should be next to the commander and XO. Attach speakers to phones and radios so the commander and XO can turn up the volume when they want all members of the TOC to hear conversations (e.g., conference calls with the division commander or subordinate engineer commanders).

5. Use NCOs to ensure that reports and messages are distributed properly, update the status of maps and charts, supervise the publication of orders and graphics, and assist in developing and war gaming courses of action. RTOs monitor radios, receive reports, and update status charts as necessary. All members of the TOC must understand the concept of the operation and the commander's critical information requirements.

NATIONAL TRAINING CENTER

National Training Center, Sidewinder Team

By Major Tom Buning

Engineer Strengths. Most engineer battalion combat service support planners, headquarters and headquarters company commanders, and the support platoon leadership are planning, coordinating, and executing resupply operations to standard. They are addressing the following tasks:

- Order the correct type and number of logistics packages (LOGPACs).
- Coordinate movement to and from logistics rally points with a battalion LOGPAC or with task force LOGPACs. This distribution system increases command, control, security, and synchronization with the supported maneuver unit's time line.
- Develop a system to coordinate changes in logistics requirements due to last-minute adjustments in task organizations and critical requirements received from status reports.
- Release and return LOGPACs promptly.
- Establish a standard resupply technique that meets your requirements.

Recommend each battalion develop a standing operating procedure (SOP) for LOGPAC operations.

Engineer Weakness. The Family of Scatterable Mines (FASCAM) planning and trigger points need emphasis. Recommend engineers know the doctrine for planning and employing FASCAM, as described in FM 90-7. To provide the commander maximum flexibility, develop plans to employ FASCAM throughout the depth and width of the sector or zone in sufficient numbers to support the base plan and all branch plans. Execute FASCAM based on an enemy event trigger, using named areas of interest (NAI) in the deep battle area that are tied to decision points. Assign dedicated observers (both primary and alternate) to overwatch the NAI. Assign other dedicated observers to the FASCAM target area to direct artillery and close air support. They must synchronize the location, trigger, and execution criteria for FASCAM during war gaming.

Engineer Solution

The squad leader's assessment and calculations are incorrect. The following calculations are correct:

Top Attack

1. Determine the height-to-length ratio:

$H/L = 1.1/35 = 0.031$ (Round up to 0.04 on Table H-2.)

2. Determine the average length of the bearing supports:

$$\frac{(L_S1)0.9 + (L_S2)0.8}{2} = \frac{1.7}{2} = 0.85\ m$$

3. Determine the average length of bearing supports to the length ratio (Ls/L):

$\frac{0.85}{35} + 0.24$ (Round up to 0.03 on Table H-2.)

4. Determine the length of cut (Lc):

Using FM 5-250, Table H-2, intersect the values from steps 1 and 3, above, to get Lc/L:

$Lc/L = 0.029$

Multiply (Lc/L) 0.029 by (L) 35 to get Lc; Lc = 1.01 m

Charge Calculations

1. Determine the amount of TNT required:

$P = 3.3[(3.3 \times 1.1) + .5]^3$

$P = 3.3(3.63 + .5)^3$

$P = 3.3(4.13 \times 4.13 \times 4.13)$

$P = 3.3(70.444997)$

$P = 232.46$

2. Determine the amount of explosives (TNT) for the slab:

$P = 232.46 \times 6$

$P = 1394.76$

3. Determine the equivalent amount of C4:

$$P = \frac{1394.76}{1.34} = 1040.86$$

4. Determine the required packages of C4:

$N = \frac{1040.86}{1.25} = 832.68$ (round up) 833 packages of C4

Bottom Attack

1. Determine the height-to-length ratio:

$H/L = 0.031$ (same as Top Attack calculation)

2. Determine the total end clearance (E):

$E = (E1)\ 0.2 + (E2)\ 0.5;\ E = 0.5\ m$

3. Determine the required end-clearance-to-length ratio (ER/L) using Table H-1:

ER/L = 0.003

(ER/L) 0.003 x (L) 35 = 0.105; ER = 0.105 m

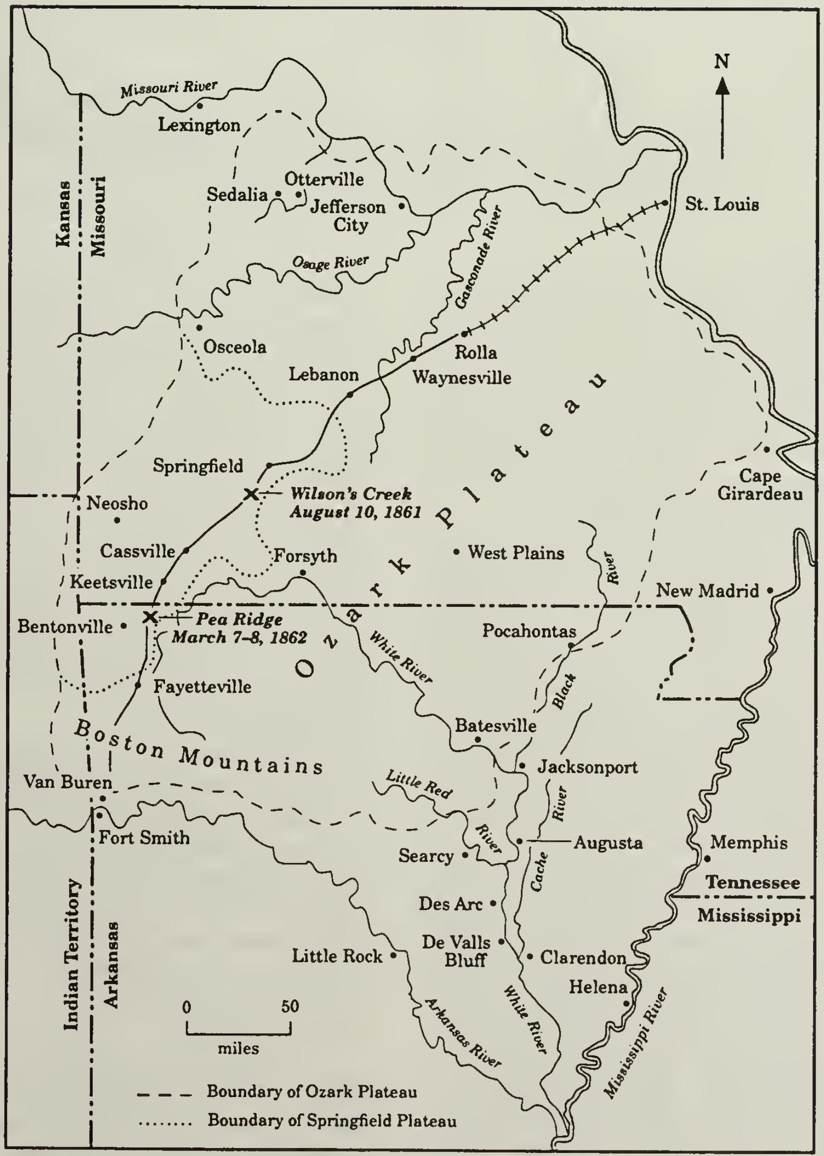
Again, the squad leader's assessment is incorrect. Because this is a preliminary target, the unit should use the quickest method of demolition—in this case, a top attack. Since E (0.5) is greater than ER (0.105), a bottom attack can be performed successfully without attacking the abutment.

"Go and Do It":
Obstacles at the Battle of Pea Ridge

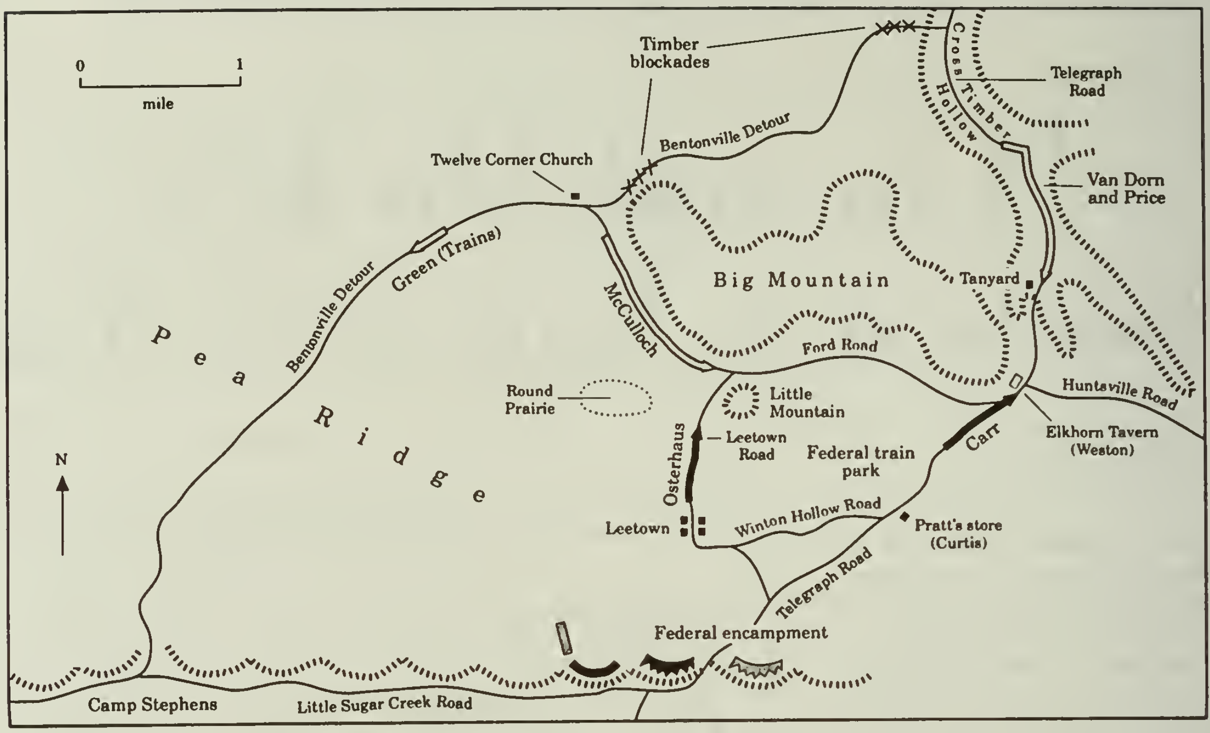
By Lynn McFarland

In 1816, Napoleon wrote in a letter, "A battle sometimes decides everything; and sometimes the most trifling thing decides the fate of a battle."[1] A perfect example of this occurred during the Civil War when, in early March 1862, two road obstacles helped the U.S. Army of the Southwest secure Missouri. Brigadier General Samuel R. Curtis, commander of the Army of the Southwest, placed two obstacles behind his army's right flank to deny Confederate forces access to the rear. As the Confederate Army of the West maneuvered around Curtis' position, the obstacles caused its forces to split. Curtis was then able to turn his army and defeat the divided Confederates at the Battle of Pea Ridge. This ended any serious Confederate threat to Missouri for the remainder of the war.

In late 1861, the fight for Missouri was at a standstill. Union forces held St. Louis and the Missouri River Valley, but the pro-Confederate Missouri State Guard, commanded by Major General Sterling Price, held Springfield, located in the southwest corner of the state. The overall Union commander of Missouri, Major General Henry W. Halleck, knew that Price's ragtag force threatened to disrupt his upcoming offensives on the Mississippi, the Tennessee, and the Cumberland Rivers. St. Louis was the main



Map 1



Map 2

base of operations for these campaigns, and if Halleck moved forces out of Missouri to support the operations, Price could move into the interior of Missouri and threaten St. Louis. In this way, Price could use a comparatively small force to check a much larger one.

Halleck realized that he must go on the offensive in Missouri and push the Missouri State Guard out of the state as quickly as possible. On 25 December, he placed Curtis in command of the Army of the Southwest and ordered him to launch an offensive and defeat the Missouri State Guard. Once this was done, Halleck could take the idle garrison troops across Missouri and reinforce the river campaigns.

Curtis' four-division army of 12,000 soldiers left Rolla, Missouri, in mid-January 1862, headed for Price's 7,000-person army in Springfield. On 13 February, Curtis was ready to attack Springfield; but Price had moved the Missouri State Guard southwest along Telegraph Road, trying to reach Arkansas and Confederate reinforcements before Curtis could pursue and catch up.

Confederate forces in northwest Arkansas were commanded by Brigadier General Ben McCulloch. Even though McCulloch and Price had teamed up to defeat Union forces at the Battle of Wilson's Creek on 10 August 1861 (see Map 1), the two frequently quarreled over authority and objectives. To defuse the Price-McCulloch feud, Confederate President Jefferson Davis ordered Major General Earl Van Dorn to take command of all Confederate troops in Missouri and Arkansas.

On 14 February, the Army of the Southwest started after Price, but he escaped Curtis' pursuit. In late February and early March, Van Dorn ordered Price and McCulloch to unite forces, giving Van Dorn more than 15,000 soldiers. His plan was to attack and defeat Curtis' army and then advance toward St. Louis.

Curtis faced a dilemma. He had chased Price out of Missouri but had been unable to bring him to battle. Curtis' supply line was stretched to its limit with supplies having to come from Rolla by wagon. After dropping off detachments to protect the supply line, the Army of the Southwest was now down to 10,500 troops. If he wanted to continue to advance, Curtis would have to spread them out so they could forage off the countryside, which would expose them to a consolidated enemy force. If he retreated to Springfield, Price would be free to re-enter Missouri. Curtis decided to concentrate his forces in a defensive posture along Telegraph Road where it crossed Little Sugar Creek (see Map 2). Curtis told his army to dig in along the bluffs, facing south and overlooking the creek. It was a formidable defensive position.

Van Dorn's Plan

Not wanting to attack Curtis in this position, Van Dorn ordered his already-tired army to Camp Stephens, an old Confederate camp a few miles west of Curtis. They reached the camp in the afternoon of March 6th, worn out from marching through the cold, wet weather. McCulloch suggested that the army rest overnight, then move along the Bentonville Detour to a position behind Curtis. This would force Curtis to either turn and fight at a disadvantage or try to retreat to Springfield. Van Dorn agreed to the plan but ordered the exhausted army to begin the movement immediately. McCulloch was shocked. He told Van Dorn "for God sake to let the poor, worn-out and hungry soldiers rest and sleep that night ... and then attack the next morning."[2] Van Dorn disagreed and ordered the movement to begin.

The Bentonville Detour went northeast from Camp Stephens for eight miles and intersected with Telegraph Road five miles north of–and behind– Curtis' position (see Map 2). Van Dorn's march along the road would be hidden from Curtis' view by Big Mountain, a three-mile-long ridge extending from Telegraph Road on the east to Twelve Corner Church on the west. The Bentonville Detour ran along the north side of Big Mountain.

Even though Van Dorn's plan was bold and brought his forces to Curtis' rear, there were risks involved. It meant that the exhausted Confederates had to march eight miles to Telegraph Road, turn south, march another two miles through difficult terrain to reach the open fields north of Curtis' position, and then possibly fight a major battle. If Van Dorn's troops did not remain undetected, Curtis could turn his army and keep the Confederates bottled up in the rough terrain north and east of Big Mountain. Speed and surprise were critical to Van Dorn's plan.

The Confederate plan had another problem. Apparently, Van Dorn failed to understand that Curtis was looking for a fight instead of trying to avoid one. A few days after the battle, Major Ross of the 6th Texas Cavalry wrote, "The truth of the whole matter was, General Van Dorn did not believe the Federals would fight him, but rather, that they would get away from him."[3] Ignoring McCulloch and the fact that his army was deteriorating, Van Dorn went ahead with the plan.

In the meantime, the Federals had been busy. An enemy force of unknown size at Camp Stephens made Curtis nervous. Curtis ordered the units on his right flank to face west and dig in. He also ordered the roads in his immediate rear kept clear so he could maneuver troops in case his right flank was threatened. When asked what would happen next, Curtis replied, "I will either fight them tomorrow or they me."[4]

"...Do It"

About sunset on 6 March, Colonel Grenville Dodge, one of Curtis' brigade commanders, suggested that the Bentonville Detour be blocked to prevent or delay Confederate movement around the Union position. Curtis told Dodge, "...go and do it."[5] Dodge assembled six companies of the 4th Iowa Infantry and one company of the 3rd Illinois Cavalry and headed north on Telegraph Road. By 2100 hours, Dodge's detachment had turned onto the Bentonville Detour. Approximately one mile east of Twelve Corner Church, where the Bentonville Detour runs through a deep ravine, Dodge ordered his troops to cut down trees and form an abatis across the narrow road (see Map 2). Then the soldiers moved back east toward Telegraph Road and created another obstacle across the detour.

Around midnight, Dodge's pickets heard a great deal of noise on the west side of the first obstacle. Dodge gathered his makeshift engineers and returned to the main Union position along Little Sugar Creek. When Dodge reported to Curtis around 0200 hours on 7 March, Curtis did not seem alarmed at Dodge's account of enemy activity along the Bentonville Detour. He thought that Dodge had heard only a Confederate scouting party. Curtis believed that Van Dorn would spend the night at Camp Stephens—since pickets had reported seeing hundreds of campfires burning—and either attack the Union position head on or on the flank on 7 March.

Van Dorn and his subordinates ended their meeting at Camp Stephens around 1800 hours on 6 March. The march along Bentonville Detour was to begin at 2000 hours. If all went according to plan, the Army of the West should cover the eight miles to Telegraph Road by dawn and as dawn broke, be in position along Telegraph Road to attack Curtis from the rear. Confederate troops stoked their campfires before moving, hoping to deceive the enemy into thinking they were spending the night at Camp Stephens.

Things began to go wrong for Van Dorn from the beginning. He wanted Brigadier General James McIntosh's cavalry brigade in the front. But as McIntosh's cavalry tried to move up the road, its path was blocked by a horde of men and equipment. Somehow, Price's Missouri State Guard had formed up on the road ahead of McIntosh. Instead of having faster-moving cavalry scouting ahead of his march, Van Dorn was leading with a slow-moving mass of infantry and artillery.

By 2000 hours, most of the Confederate regiments were in column along the road, but they were plagued by disorganization, confusion, and dropping temperatures. Near the Bentonville Detour, troops were hampered by the lack of a bridge across Little Sugar Creek. Soldiers threw logs into the creek, broke ranks to cross the freezing water, and then reformed on the other side. It wasn't until 2300 hours that the last of Price's men crossed the creek and started along the Bentonville Detour. Colonel Louis Hebert's infantry brigade came next, and about 0200 hours on 7 March, McIntosh's cavalrymen, who were

General Grenville M. Dodge

supposed to be leading the march, crossed the creek. Around dawn, the last units of the army finally began to cross.

The unbridged Little Sugar Creek was not the last obstacle that Van Dorn's tired and cold soldiers had to contend with. About midnight, the head of Price's column found the maze of trees felled by Dodge's makeshift engineers. The entire column waited as the Missouri State Guard cleared the road. After a two-hour delay, the advance began again, only to find a second abatis farther down the road. Two more hours were lost while the Guard cleared the road once more. At dawn, when Van Dorn planned to have his entire force assembled on Telegraph Road, the head of his column was just reaching the Telegraph Road intersection, while the tail was still at Camp Stephens.

Not only was Van Dorn falling behind schedule, his army was falling apart also. The hard march to Camp Stephens, the cold weather, a shortage of food, and the lack of rest were causing Van Dorn to lose his numerical superiority. A Texas cavalry officer wrote, "Every half mile I saw infantry in squads of 50 or 60, and even more lying on the roadside, asleep and overcome with hunger and fatigue."[6]

The Battle

At 0700 hours on 7 March, Missouri State Guard cavalry turned off the Bentonville Detour onto Telegraph Road and began moving south. Not a Yankee was in sight. Van Dorn's plan had worked; he had deceived Curtis and was now behind him. But Van Dorn's forces were spread out, and it would be well into the afternoon before he could consolidate his column, giving Curtis plenty of time to detect him and react. Van Dorn had to find a way to unite his army quickly.

Van Dorn, traveling near the head of the column with Price, decided to divide the army. Price's Missouri State Guard would turn south off the Bentonville Detour onto Telegraph Road and advance two and a half miles to Elkhorn Tavern (see Map 2). McCulloch's Confederate division would leave the Bentonville Detour at Twelve Corners Church and turn south on Ford Road, uniting with Price's forces at Elkhorn Tavern. Ford Road lay along the south side of Big Mountain and intersected Telegraph Road just south of Elkhorn Tavern. By taking Ford Road instead of the Bentonville Detour, McCulloch would march only three and a half miles instead of seven.

McCulloch received the orders after the head of his column had passed Twelve Corner Church. He ordered a time-consuming countermarch to Ford Road. As he traveled down the column of cold, weary soldiers, he said, "We are going to take 'em on the other wing."[7] It was well into the morning before McCulloch's troops finally turned south on Ford Road. Just before noon, the head of his column was two and a half miles from Elkhorn Tavern. Van Dorn was about an hour away from uniting his army at the tavern.

Van Dorn's army was in a precarious situation. The two halves were separated by Big Mountain and each half was smaller than Curtis' entire force. But Van Dorn was confident that Curtis had not detected his movement and that by the time Curtis did notice him and react, the two halves would be reunited at Elkhorn Tavern.

But the Yankees had already observed the Confederate force and were reacting. At 0800 hours, Curtis' provost marshal reported Confederate cavalry north of Elkhorn Tavern, and a scouting party had seen Confederate infantry on the Bentonville Detour near Twelve Corner Church. By 1100 hours, Curtis had Colonel Peter J. Osterhaus' troops moving toward the church to develop the situation. He also had Colonel Eugene A. Carr's division moving toward Elkhorn Tavern. Curtis believed he was facing two Confederate forces: one at Camp Stephens preparing to attack and another on the Bentonville Detour trying to get around his right flank.

Just before noon, near the village of Leetown, Osterhaus' soldiers met with McCulloch's column. McCulloch, who had the superior numbers, quickly seized the initiative and prepared to attack Osterhaus' force. Osterhaus, realizing he was facing a significant part of the Confederate force, asked Curtis for reinforcements. Meanwhile, in the rough terrain north of Elkhorn Tavern, Carr ran into the Missouri State Guard.

Curtis soon realized that the entire Confederate army had moved to his rear. He told Carr to conduct an economy-of-force mission and try to keep the Missouri State Guard from breaking through while most of the army went to Leetown to support Osterhaus. After helping Osterhaus, the army would move to assist Carr.

As McCulloch's forces prepared to attack Osterhaus, McCulloch moved forward with the 16th Arkansas Infantry Regiment on a personal reconnaissance and was killed by skirmishers of the 36th Illinois Infantry Regiment. Brigadier General McIntosh assumed command and advanced with the 2nd Arkansas Mounted Rifles, but the 36th Illinois skirmishers killed him also. Command now fell on the shoulders of Colonel Hebert, although he never learned that he was in command. Hearing the firing from the 36th Illinois, Hebert took it as the signal to attack. He led his command of four infantry regiments into arriving Union reinforcements and, after some initial success, his attack was broken up and he was captured. Because of the deaths or capture of the three Confederate commanders, McCulloch's division never was able to bring its superior numbers to bear on Osterhaus.

Late in the day, McCulloch's division, now commanded by Colonel Elkanah Greer, returned to Twelve Corner Church. Some of the Confederate soldiers returned to Camp Stephens while others took the Bentonville Detour, trying to find Van Dorn and the rest of the army.

While Osterhaus held off McCulloch's unorganized attack, Carr earned a Medal of Honor for keeping the larger Missouri State Guard in the rough terrain north of Elkhorn Tavern. By using artillery early in the fight and small counterattacks at critical moments and by bending back his right flank, Carr kept Price and Van Dorn off balance most of the afternoon. It wasn't until late in the day that Van Dorn was able to mass the larger Missouri State Guard against Carr and drive him away from Elkhorn Tavern. But by then it was too late; the sun was gone, Union reinforcements were arriving, and McCulloch wasn't coming to help.

That night the Union Army, resupplied from their wagons, deployed to deliver the decisive blow against Van Dorn, who was unable to resupply because his supply wagons were still at Camp Stephens.

Victory

On 8 March, realizing he was almost out of ammunition, Van Dorn ordered his army to retreat eastward. Just as the Confederates were leaving, Curtis attacked. He misinterpreted the direction of the Confederate withdrawal, believing that Van Dorn was retreating northward up Telegraph Road along the route of his advance the day before, and ordered the pursuit northward. What was left of Van Dorn's army slipped away to the east.

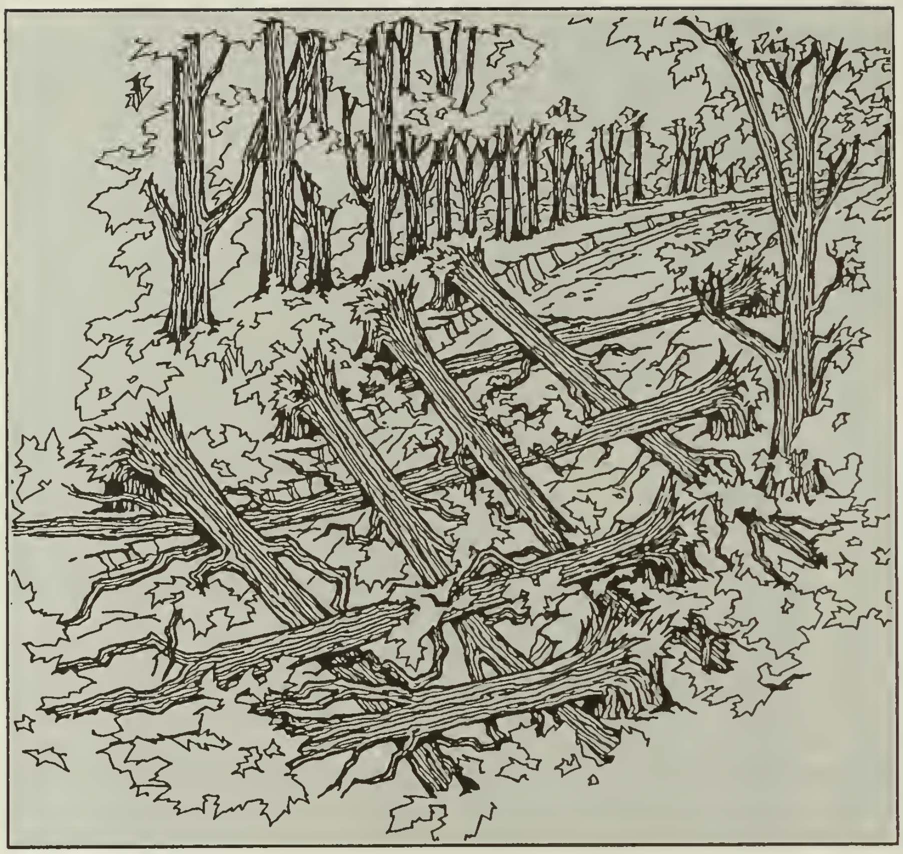
The Battle of Pea Ridge was a tactical draw. Van Dorn had turned Curtis' superior position, but Curtis was able to keep him from massing the Confederate Army. The Union Army suffered approximately 1,400 casualties in the battle. Confederate losses were hard to establish and may never be known, but they were at least as high as the Union's and probably higher.

Strategically, the battle was a Union victory. Curtis used the battle to regain the initiative and moved his army into central Arkansas. Van Dorn's commander, General Albert S. Johnston, ordered Van Dorn's soldiers to reinforce Confederate troops in Mississippi. Even though skirmishing and bushwhacking continued in Missouri for another three years, Missouri was securely in Union hands.

Obstacle Integration

Van Dorn's turning movement along the Bentonville Detour faltered for a number of reasons: poor staff work, tired soldiers, and quick reaction from Union forces. However, Dodge's obstacles may have been the most important reason since they cost Van Dorn four hours and caused him to divide his army.

What factors did Curtis and Dodge consider at Pea Ridge that are still important to obstacle planners today? One of the most important aspects of obstacle planning is the engineer battlefield assessment (analysis of terrain and enemy and friendly forces). Certainly, both Curtis and Dodge considered the terrain and possible avenues of approach when they discussed creating



An abatis such as this was used in the Battle of Pea Ridge.

obstacles along the Bentonville Detour. Dodge took the terrain into consideration when he decided to chop down the trees in the two deep ravines. They also considered the fact that the enemy's tactics would likely include an envelopment or turning movement. The choice of abatis as obstacles was probably based on the amount of time and friendly assets (infantry with hand tools) available and an analysis of the Confederate's assets (infantry with hand tools).

Today's army would classify Dodge's obstacles as reinforcing obstacles. FM 90-7 states, "Reinforcing obstacles are obstacles specifically constructed, emplaced, or detonated by military forces. The categories of reinforcing obstacles are tactical and protective."[8] Dodge's obstacle would best be described as a tactical obstacles because they attack enemy maneuver. According to FM 90-7, "Tactical obstacles directly attack the enemy's ability to move, mass, and reinforce."[9] This is what Curtis and Dodge were trying to do. They wanted the obstacles to delay any Confederate units that were using the Bentonville Detour to move around the Union right flank.

FM 90-7 explains, "Obstacle intent is how the commander wants to use tactical obstacles to support his scheme of maneuver."[10] Obstacle intent consists of three components; target, effect, and relative location. Curtis and Dodge must have also considered these things.

The target of an obstacle is the enemy force that the commander wants to affect with the tactical obstacle. Commanders usually identify the target in terms of size, type of enemy force, echelon, the avenue of approach, or a combination of these. Curtis and Dodge simply targeted any size Confederate force attempting to use the avenue of approach defined by the Bentonville Detour.

The effect that a commander wants the obstacle to have on the enemy is called the obstacle effect. Tactical obstacles produce one of four effects; disrupt, turn, fix, or block. Curtis probably intended the obstacle to disrupt the Confederates. According to FM 90-7, "The disrupt effect focuses ... obstacle effort to cause the enemy to break up its formation and tempo, interrupt its timetable, ... and piecemeal the attack."[11]

Dodge's obstacles could not possibly have stopped a determined Confederate movement, but they certainly could, and did, interrupt the Confederate timetable and disrupted Van Dorn's command and control. Curtis probably did not want to block Confederate movement. Evidence of this is that he did not cover the obstacles with fire. If he had wanted to deny the Confederates use of the road, he probably would have deployed forces at the obstacles.

Relative location of an obstacle refers to where the commander wants the obstacle to affect the enemy. Curtis was not specific about this aspect which allowed Dodge to choose the best location for the obstacles based on his ground reconnaissance.

FM 90-7 emphasizes the importance of integrating fires and obstacles: "All leaders must understand how obstacles and fires mesh to achieve the obstacle effect."[12] Dodge's obstacles were not covered by fire, yet they seemed to be effective for a number of reasons.

First of all, the Confederates failed to conduct a reconnaissance. Due to poor staff work and the condition of Van Dorn's troops, Missouri State Guard units led the advance instead of McIntosh's cavalry brigade. Had Van Dorn led with cavalry, they might have discovered the obstacles, allowing him to plan how to deal with them. Van Dorn might have even decided to turn the entire force at Twelve Corner Church instead of just McCulloch's division. This would have completely changed the nature of the battle.

Another reason the obstacles were effective was that they were deployed in depth. By using two obstacles instead of one, Dodge forced Van Dorn to stop and restart his column twice. Stopping and restarting movements is difficult for even the best staff. After working hard for two hours clearing an obstacle, imagine the impact on morale of coming across another obstacle two miles later.

Of course, the location of the obstacles increased their effectiveness. Dodge chose natural choke points—where the road ran through deep ravines. The steep sides of the ravines made it very hard, if not impossible, for Van Dorn's soldiers to leave the road, march around the obstacle, and return to the road on the other side. It probably would have taken just as long to struggle around the obstacles as it would have to breach them.

Major General Franz Sigel, one of Curtis' division commanders, summed up the Battle of Pea Ridge very appropriately:

> *It was not a great battle, like that of Gettysburg or Chattanooga; it was not of such preponderating national importance; it did not break the backbone of the Rebellion, but it virtually cleared the Southwest of the enemy...and made it possible for our veterans to reinforce the armies under Buell, Rosecrans, Grant, and Sherman.*[13]

Dodge's obstacles obviously played a key role in the Union victory. As Napoleon wrote, "A battle sometimes decides everything; and sometimes the most trifling thing decides the fate of a battle."[14]

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Endnotes

[1] Heinl, Robert Debs, Jr., Editor. *Dictionary of Military and Naval Quotations.* Annapolis: U.S. Naval Institute, 1966, p. 26.

[2] Shea, William and Earl Hess. *Pea Ridge, Civil War Campaign in the West.* Chapel Hill: University of North Carolina Press, 1992, p. 80.

[3] Shea, p.82.

[4] Ibid.

[5] Ibid.

[6] Shea, p.86.

[7] Shea, p.87.

[8] Department of the Army. FM 90-7: *Combined Arms Obstacle Integration.* Washington: Headquarters, Department of the Army, 1994, p. 2-1.

[9] Department of the Army, p. 2-2.

[10] Department of the Army, p. 2-4.

[11] Ibid.

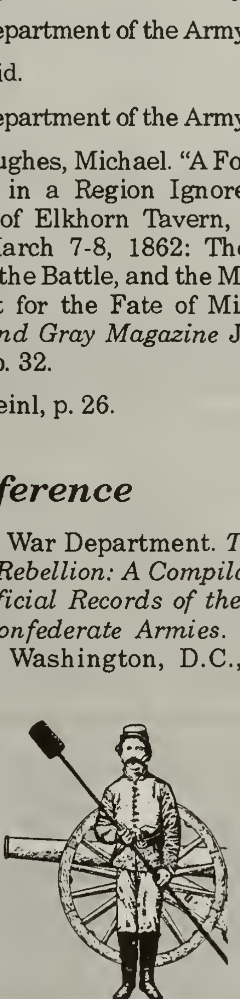
[12] Department of the Army, p. 3-2.

[13] Hughes, Michael. "A Forgotten Battle in a Region Ignored, Pea Ridge of Elkhorn Tavern, Arkansas, March 7-8, 1862: The Campaign, the Battle, and the Men Who Fought for the Fate of Missouri." *Blue and Gray Magazine* January 1988, p. 32.

[14] Heinl, p. 26.

Reference

U.S. War Department. *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies.* 70 volumes, Washington, D.C., 1880-1901.



(Continued from page 16)

Understanding. The engineer community is not fully trained about EBA. Many units gloss over the importance of EBA, and this weakness is immediately apparent when they go to the Combat Training Centers. Units must consistently use the intelligence NCO and the EBA process during all exercises. To increase the effectiveness of the brigade combat team, the intelligence NCO, the assistant brigade engineer, and the brigade S2 sections must find ways to train together frequently.

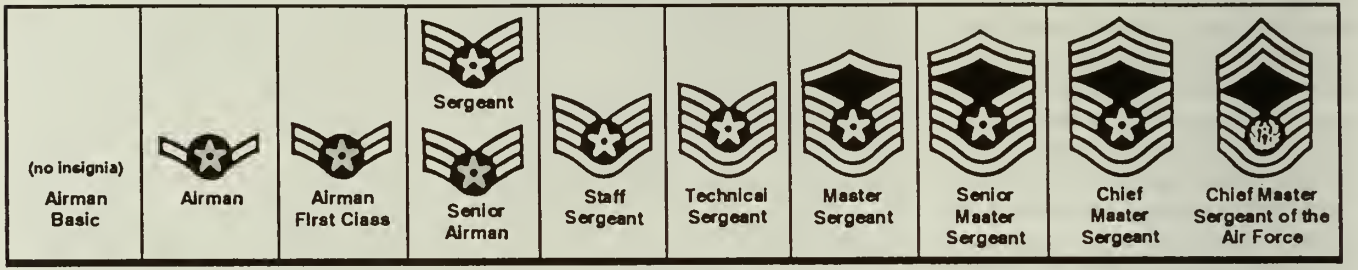
Conclusion

The EBA is a continuous process that requires frequent updating from the time a mission is received until it is accomplished. The EBA must be adjusted based on information from both higher and lower echelons. Initially, the EBA is part of the situation report in the mission analysis brief to the commander. The EBA/IPB and the situation template/most likely course of action drive the planning process from start to finish. When executed poorly or not at all, the EBA and the parallel planning process hinder even the best plan. When they are executed well, the processes complement each other and ensure mission accomplishment on the battlefield.

Michael W. Sayer is a military analyst for the Sidewinder Engineer Battalion Trainers, Operations Group, National Training Center, Fort Irwin, California. He recently retired from active duty after spending two years as the intelligence NCO for the 4th Engineer Battalion at Fort Carson, Colorado.

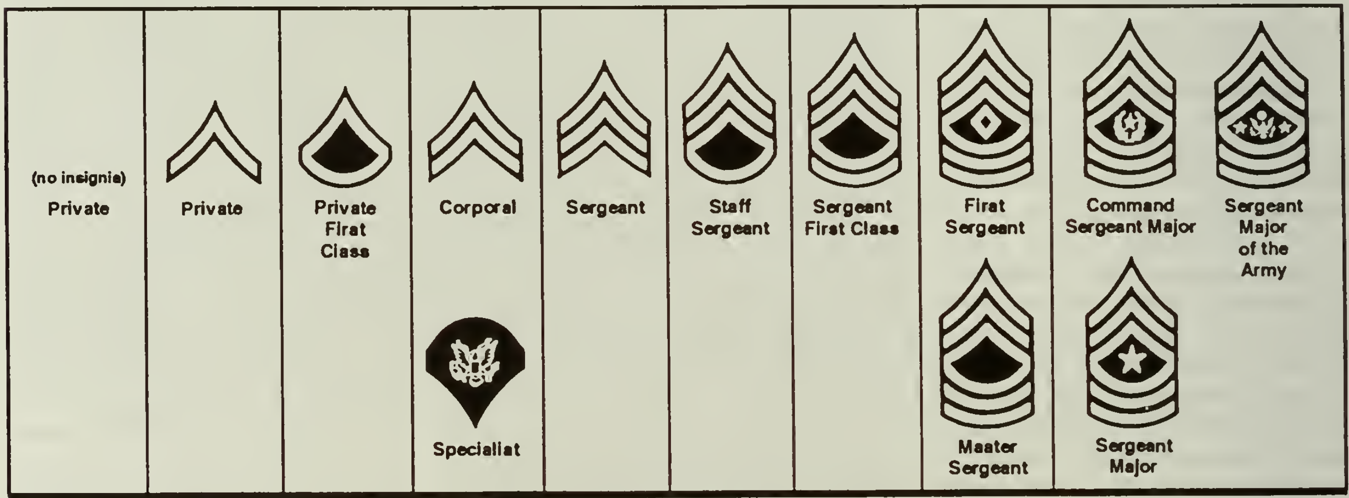
Enlisted Insignia of the United States Armed Forces

AIR FORCE



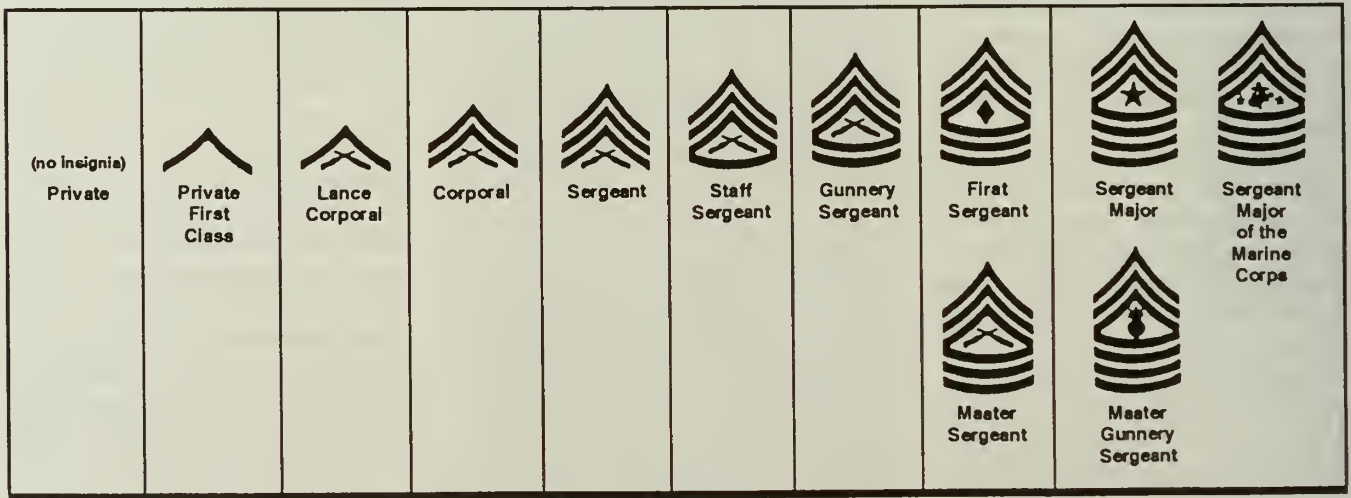
E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
(no insignia) Airman Basic	Airman	Airman First Class	Sergeant Senior Airman	Staff Sergeant	Technical Sergeant	Master Sergeant	Senior Master Sergeant	Chief Master Sergeant Chief Master Sergeant of the Air Force

ARMY



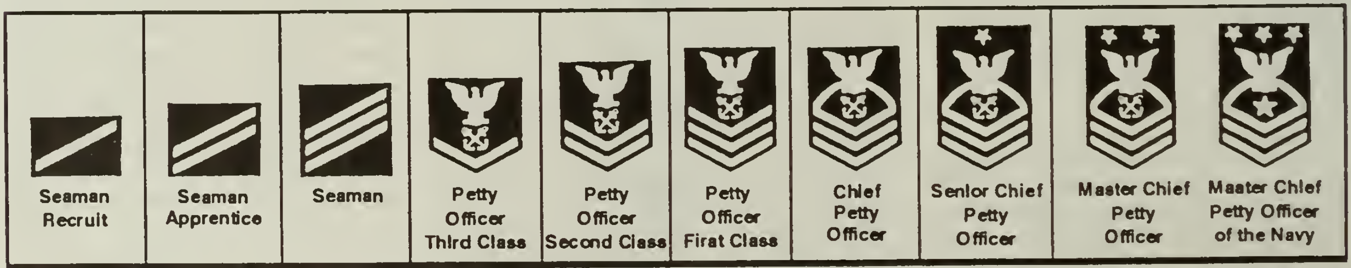
E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
(no insignia) Private	Private	Private First Class	Corporal Specialist	Sergeant	Staff Sergeant	Sergeant First Class	First Sergeant Master Sergeant	Command Sergeant Major Sergeant Major of the Army Sergeant Major

MARINES



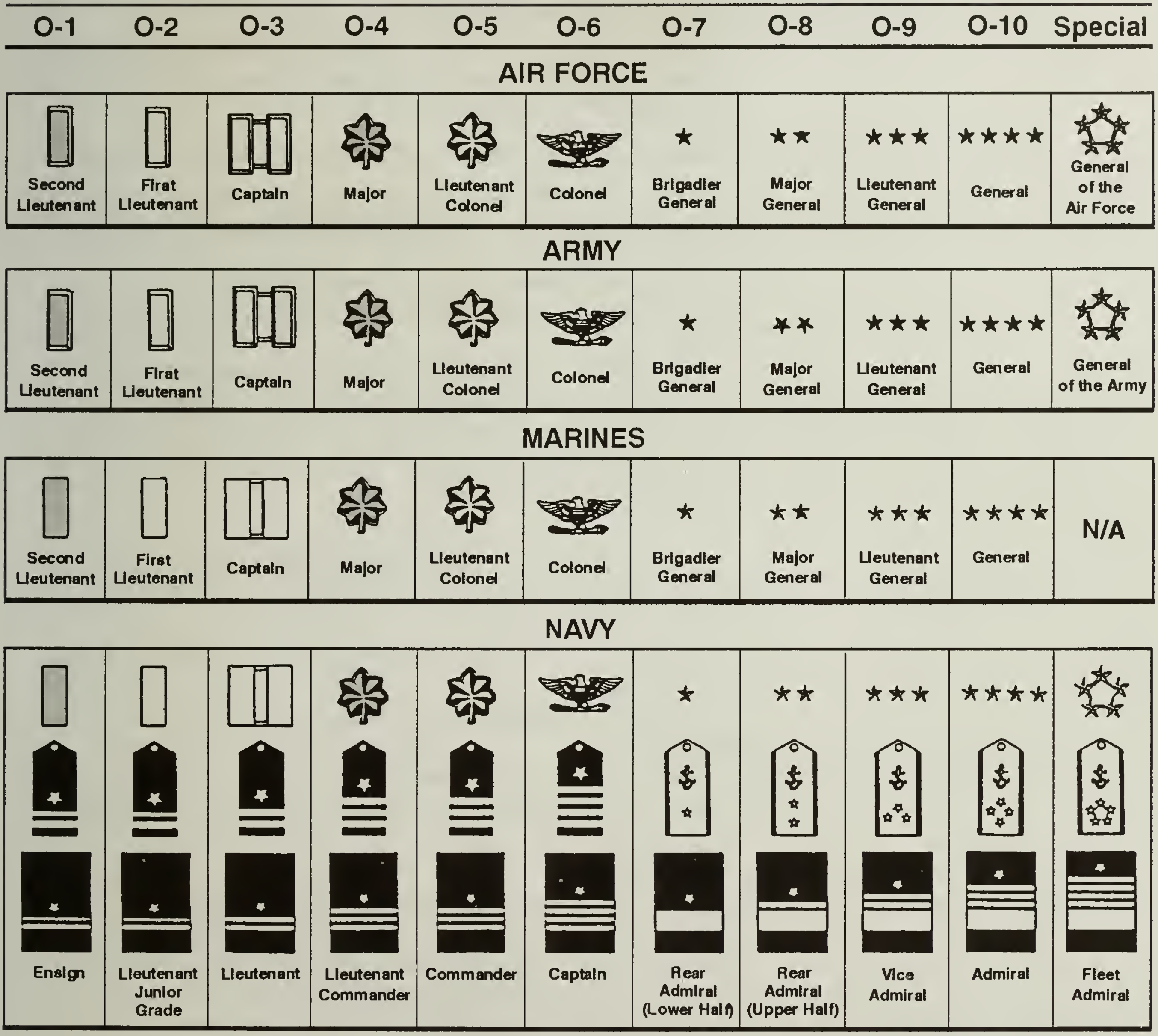
E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
(no insignia) Private	Private First Class	Lance Corporal	Corporal	Sergeant	Staff Sergeant	Gunnery Sergeant	First Sergeant Master Sergeant	Sergeant Major Sergeant Major of the Marine Corps Master Gunnery Sergeant

NAVY



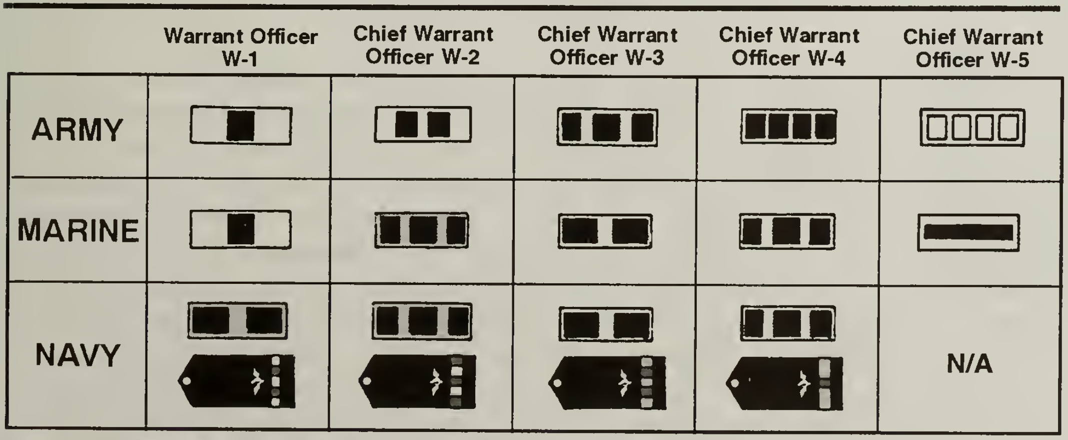
E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
Seaman Recruit	Seaman Apprentice	Seaman	Petty Officer Third Class	Petty Officer Second Class	Petty Officer First Class	Chief Petty Officer	Senior Chief Petty Officer	Master Chief Petty Officer Master Chief Petty Officer of the Navy

Officer Insignia of the United States Armed Forces



	O-1	O-2	O-3	O-4	O-5	O-6	O-7	O-8	O-9	O-10	Special
AIR FORCE	Second Lieutenant	First Lieutenant	Captain	Major	Lieutenant Colonel	Colonel	Brigadier General	Major General	Lieutenant General	General	General of the Air Force
ARMY	Second Lieutenant	First Lieutenant	Captain	Major	Lieutenant Colonel	Colonel	Brigadier General	Major General	Lieutenant General	General	General of the Army
MARINES	Second Lieutenant	First Lieutenant	Captain	Major	Lieutenant Colonel	Colonel	Brigadier General	Major General	Lieutenant General	General	N/A
NAVY	Ensign	Lieutenant Junior Grade	Lieutenant	Lieutenant Commander	Commander	Captain	Rear Admiral (Lower Half)	Rear Admiral (Upper Half)	Vice Admiral	Admiral	Fleet Admiral

WARRANT



	Warrant Officer W-1	Chief Warrant Officer W-2	Chief Warrant Officer W-3	Chief Warrant Officer W-4	Chief Warrant Officer W-5
ARMY					
MARINE					
NAVY					N/A

The Air Force does not have warrant officers.

COAST GUARD

Coast Guard officers use the same rank insignia as Navy officers. Coast Guard enlisted rating badges are the same as the Navy's for grades E-1 through E-8. E-9's have silver specialty marks, eagles and stars, and gold chevrons. The badge of the Master Chief Petty Officer of the Coast Guard has a gold chevron and specialty mark, a silver eagle and gold stars. For all ranks, the gold Coast Guard shield on the uniform sleeve replaces the Navy star.

ENGINEER UPDATE

Commercial numbers are (314)563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training and Doctrine (DOTD)

New Field Manuals (FMs). Four FMs were distributed in October:

- FM 5-10, *Combat Engineer Platoon*, is a companion manual for FM 5-34 that describes how the engineer platoon supports the total combined-arms effort.
- FM 5-125, *Rigging*, addresses the types of rigging and the applications of fiber rope, wire rope, and chains used to move heavy loads.
- FM 5-426, *Carpentry*, is a guide for engineers responsible for planning and executing theater-of-operations construction.
- FM 5-71-3, *Brigade Engineer Combat Operations (Armored)*, is a guide for brigade engineers, their staffs, and subordinate commanders.

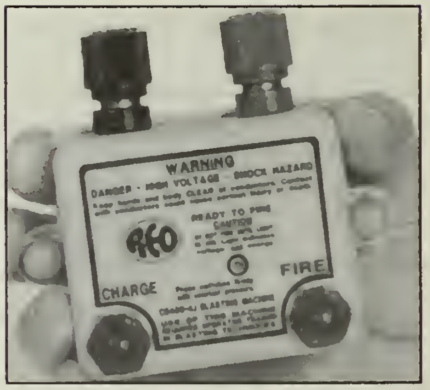
POC is Sandra Gibson, -4100.

New Army Training and Evaluation Programs (ARTEPs). Three ARTEPs distributed in October provide programs to train units in their critical wartime missions:

- ARTEP 5-402-33-MTP, *Mission Training Plan for Engineer Groups and Brigades.*
- ARTEP 5-413-33-MTP, *Mission Training Plan for Engineer Support Companies.*
- ARTEP 5-500-24-MTP, *Mission Training Plan for Engineer Diving Teams - Heavy Engineer Diving Team/Light Engineer Diving Team.*

POC is Rayburn Toy, -4102.

Directorate of Combat Developments (DCD)



COTS Blasting Machine

Commercial Off-The-Shelf (COTS) Blasting Machine. The new CD450-4J blasting machine to replace the current M-34 will be available in January 1996. Units will be able to requisition this item through normal supply channels using the assigned NSN 1375-01-417-7104. The item manager reports that back-order requisitions for M-34s will be filled initially with this item; follow-on requisitions will be filled after all back orders are filled. POC is Larry Allen, -4080.

Small Emplacement Excavator (SEE) Attachments. Fielding of a boom-mounted earth auger for the SEE began in April 1995 and will be completed in February 1996. This auger provides engineer units the capability to bore holes 6 feet deep and 12 inches across. Units can also purchase a boom-mounted pavement breaker and a tamper/compactor. A front-mounted rotary sweeper and a snow-blade attachment have been approved for use. The U.S. Army Tank-Automotive and Armaments Command is completing a Technical Data Package List of all attachments that will be available soon. It will include drawings, instructions, and suggested manufacturers for equipment procurement. POC is Cathy Pryor, -6185.

BRIDGE THE GAP

By Command Sergeant Major Roy L. Burns, Jr.
U.S. Army Engineer School

Physical Fitness and NCO Professional Development

"The best form of "welfare" for the troops is first-class training, for this saves unnecessary casualties."

Field Marshal Erwin Rommel

Since enrollment requirements for attendance at Noncommissioned Officer Education System (NCOES) courses changed in April 1995, many eyebrows at the Engineer Center and throughout the Army have been raised in concern. Department of the Army message, DTG 081650Z, March 95, subject: APFT Height and Weight Requirements, states that soldiers must pass the Army Physical Fitness Test (APFT) and meet height/weight requirements prior to enrollment in NCOES courses.

Senior Army leaders are concerned because many NCOs fail to meet these requirements. Since April, Engineer Center records show that 31 soldiers enrolling in the Primary Leadership Development Course (PLDC), 15 enrolling in the Basic NCO Course (BNCOC), and 7 enrolling in the Advanced NCO Course (ANCOC) failed to meet entry requirements. Those soldiers were denied training and returned to their units—with their units absorbing the temporary duty (TDY) expenses.

These figures should be zero! They cause us to question the physical condition of engineer soldiers and the physical fitness standards upheld in units. When we must return soldiers to their units, it directly impacts the soldiers' careers and indirectly impacts their units' readiness. It sends a clear message that the soldier and the unit are not upholding the standards outlined in Army regulations.

Notice: In accordance with the Department of the Army (DA) message dated March 1995, the Commandant of the Libby NCO Academy must forward a letter of release to the first general officer in the student's chain of command. This policy was established by DA and is strictly enforced at Fort Leonard Wood. We are the leaders who must send soldiers who do not meet enrollment requirements back to their units, but we are not the "bad guys" some call us. The Engineer Center is committed to helping soldiers succeed!

The leadership in our corps must prepare soldiers for NCOES schooling. First-line leaders and commanders are responsible for helping young NCOs better prepare for their careers and provide time for them to prepare for schooling. Many students arriving at the Engineer Center say they had only a week's notice, or less, before reporting to school. This is not the way to take care of soldiers.

To improve NCOES entry rates, first-line leaders must take time to know their soldiers' strengths and weaknesses and then provide training to overcome the weaknesses. This stragegy will prepare soldiers for successful entry to NCOES courses—and for the demands they will face on the battlefield.

Training Strategy: The following suggestions will help prepare soldiers for NCOES courses.

- Ensure that soldiers scheduled to attend schools are mentally and physically prepared.

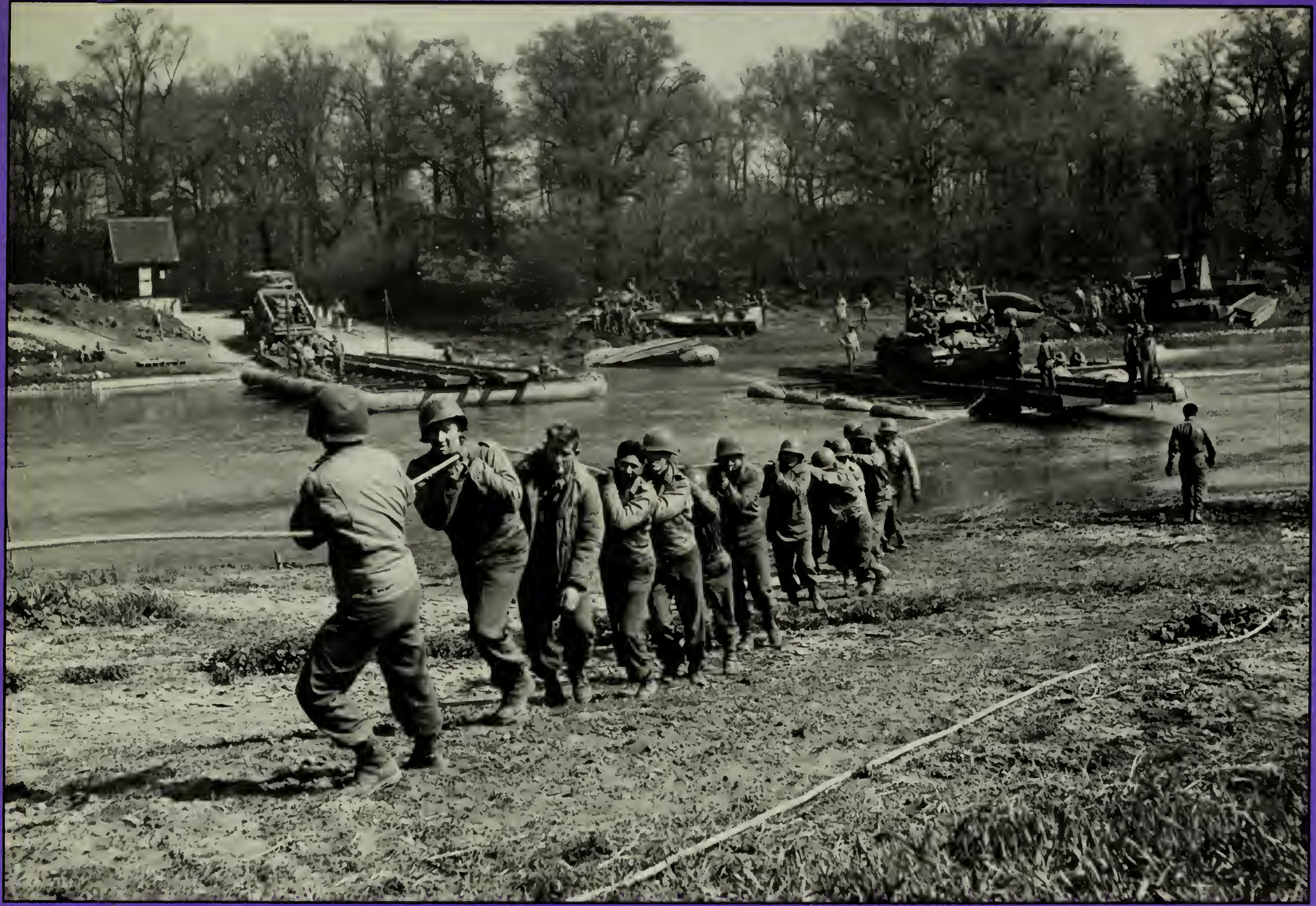
- Give a thorough physical fitness test, to Army standards, 30 days prior to the soldiers' report date. Send only those who pass to the course.

- When necessary, administer a tape test and counsel soldiers on the weight-control policies outlined in AR 600-9. Do this long before soldiers with potential weight problems must report. Failure to meet the standards outlined in AR 600-9 affects school attendance and is detrimental to the career potential of otherwise outstanding soldiers.

- Set a positive example for your soldiers. Make and take time to counsel, train, and lead by example. Soldiers expect and desire strong role models who uphold strong Army standards and traditions.

- Discuss with your soldiers their responsibiltiy to be strong and to stay strong. The bottom line is that soldiers must assume responsibility for their physical fitness.

NCOs in the Engineer Regiment must invest more time in training high-quality soldiers—those who are prepared to meet any challenge at a moment's notice. We must maintain our great NCO Corps, Regiment and, above all, our great Army.



Combat engineers of the 83rd Division pull a tank across Germany's Seale River in April 1945.

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